UNIVERSITY OF ZULULAND

Real Exchange Rate Misalignment and Growth of Tradable Sectors in South Africa: A Sectoral Dynamic Panel Data Approach

By

Brian Tavonga Mazorodze

Student Number: 201640053

2017

Dissertation submitted to the faculty of Commerce, Administration and Law in fulfilment of the requirements for the degree of Masters of Commerce in the Department of Economics at the University of Zululand

Supervisor – Professor D.D. Tewari

Declaration

I, Brian Tavonga Mazorodze, declare that this dissertation is my original work and that it has not been presented for a degree at this or any other university. Acknowledgement has been duly given where work of others has been used.

Brian Tavonga Mazorodze:

Date: 20/01/2017

Certificate of Approval

We declare that this thesis is from the student's own work and citations have been made where other sources of information have been used. This thesis is therefore submitted with our approval.

Supervisor: Professor D.D Tewari ……………………………………………..……………

Date: ……………………………………………………………………………...……………..

Acknowledgements

I thank God almighty for seeing me through this difficult and challenging year taking into account the protests that disturbed to a greater extend teaching and learning activities. I am deeply indebted to my supervisor Professor Tewari for his intellectual guidance and unwavering support throughout the process of dissertation writing. I am thankful as well to the entire department of Economics at the University of Zululand for their constructive criticism. Particular thanks goes to Professor Kaseeram, Professor Contogiannis and Mr Mavodyo for their useful comments on the proposal presentation of this research. I am also grateful for insights and support from Prof Kaseeram and the help he offered through-out the research processes that this research had to formally follow. If not him, it would have been a different story. Surely, I have never seen such a generous and hardworking man.

I extend my warm appreciation to Prof Strydom of Western Cape University for his constructive criticism at the proposal stage of this thesis. I thank as well participants of the Management of Business and Legal Initiatives (MBALI) (2016) conference at Richards Bay for their invaluable insights. In particular, special thanks go to Christian Tipoy of the University of KwaZulu-Natal for useful insights and suggestions on earlier version of the manuscript.

I thank Mr Mavodyo for his brotherly care and love throughout the dissertation writing. I am grateful to Mr Mutsau for instilling the passion and energy to keep working hard on this thesis. To my brother Benson Mazorodze, thank you for all your financial and moral support. I express my deep appreciation to my parents, brothers and sisters. To my friends Harris, Zhou, Vhusi, Makoba, S.K, Ruth and Nana, thanks very much, and to Dorcas Marange, you are so important to me; I will forever thank you even without your permission.

Dedication

In memory of my late sister, Familiar.

Abstract

Disappointing growth outcomes in South Africa on the back of a weakening currency have once again underscored the need for examining carefully how undervaluation relates to economic growth. Evidence on this subject has been accumulated from aggregate studies which do not take us far in understanding how undervaluation affects particular sectors. This study contributes to the existing knowledge by using a sectoral approach to establish the link between undervaluation and growth of South Africa's agriculture, mining, manufacturing, tourism, personal services and financial sector for the period 1985 through 2014. It addresses endogeneity of the real exchange rate by using the system Generalised Methods of Moments (GMM) technique and reverse causation by using initial rather than contemporary values of explanatory variables. Two measures of undervaluation are used. The first baseline measure is adjusted for the Balassa-Samuelson effect by regressing the bilateral exchange rate between the South African rand and the United States dollar on income per capita using the dynamic ordinary least squares technique. The second measure is computed from a model of a small open economy where the exchange rate is undervalued if the prevailing real exchange rate is lower than the equilibrium real exchange rate dictated by its fundamentals. Using these two measures as regressors in a conditional convergence growth specification, a positive and significant relationship between undervaluation and sectoral growth emerges with a percentage increase in undervaluation being estimated to raise average annual growth by 0.17 per cent holding constant sector specific factors. This effect increases with capital accumulation rather than employment creation and is particularly more relevant and sizeable for sectors that start off poor. These findings are robust to using alternative panel estimation techniques that include the Augmented Mean Group (AMG) and the Common Correlated Effects (CCE) estimators.

Time series techniques are then employed to track the effect of undervaluation on individual sectors. Using the bounds testing procedure due to a mixture of variable integration, the results indicate that the impact of undervaluation is not uniformly distributed across sectors. In the short-run period, undervaluation promotes growth in the tourism, financial, mining and personal services sectors while agriculture and manufacturing are all hampered by undervaluation both in the short-run and long-run. Only the mining sector appears to benefit from undervaluation in both short-run and long-run periods. The latter result could be reflective of immense global competition that turn South Africa's agriculture and manufacturing exports into non-tradables at the margin. Only the mining sector appears to benefit from undervaluation and we take this to reflect presence of an already high global demand for South Africa's minerals. Overall, time series results emphasize the importance of controlling sectoral heterogeneity and that the effect of undervaluation must not be generalised across sectors. For policy issues having found undervaluation promoting growth of a minor sector (mining) and hurting growth of major sectors in terms of contribution on gross domestic product, our analysis suggests that undervaluation is not the solution to South Africa's current slow growth as claimed in recent literature that support undervaluation-led growth; it is in fact part of the problem.

Table of Contents

List of Tables

List of Figures

List of Appendices

Acronyms

ADF – Augmented Dickey Fuller Test

AMG – Augmented Mean Group

BEER – Behavioural Equilibrium Exchange Rate

CCE – Common Correlated Effects

DEER – Desired Equilibrium Exchange Rate

DOLS – Dynamic Ordinary Least Squares

FEER – Fundamental Equilibrium Exchange Rate

FGLS – Feasible Generalised Least Squares

FMOLS – Fully Modified Ordinary Least Squares

GDP – Gross Domestic Product

GMM – Generalised Methods of Moments

ISIC – International Standard Industrial Classification

IMF – International Monetary Fund

NATREX – Natural Real Exchange Rate

NEER Nominal Effective Exchange Rate

OLS – Ordinary Least Squares

PMG – Pooled Mean Group

PWT – Penn World Tables

REER – Real Effective Exchange Rate

SADC – Southern Africa Development Community

SARB – South African Reserve Bank

CHAPTER 1

INTRODUCTION

1.1 Background of the Study and Problem Statement

The sluggish economic growth in South Africa against a backdrop of a weakening currency as confirmed in the 2015 quarterly bulletin released by the South African Reserve Bank (SARB, hereafter) have once again underscored the need for examining carefully how currency undervaluation relates to economic growth (SARB, 2015). This recent experience is quite contrary to the idea of undervaluation-led growth and consequently raises questions on currency depreciation as a precondition of the growth process as claimed in Rodrik (2008). Although recent years have seen an explosion of studies addressing the effects of real exchange rate misalignment particularly undervaluation on growth, much of the empirical effort has focussed on overall economic growth. Sectoral effects have not received their fair share of scholarly attention and where such empirical studies have been conducted, the results have largely been inconclusive[1] (Berg and Miao, 2010).

In Rodrik (2008) for instance, exchange rate undervaluation is found to expand production of tradables while contrary results are reported in Masunda (2011). Why results are so inconclusive is not certain but in large part reflects three methodological flaws. The first is that the majority of studies have relied mainly on overall growth, an approach which assumes sector homogeneity. Yet as pointed out by Sapir and Sekkat (1995) and Berman et al. (2012), sectoral elasticities to the exchange rate differ and they depend on the degree of sector tradability. Failure to capture such heterogeneity of sectoral responses in turn brings to the forefront an important problem of aggregation bias rendering inferences drawn from such analyses misleading (Bergman, 2006).

[1] Further complicating the picture is the fact that the theoretical literature is also divided on how real exchange rate undervaluation affects economic growth. For instance the conventional Mundell-Fleming theoretical model predicts that currency depreciation could be expansionary through expenditure switching effects that take place between domestic and foreign produced goods as long as the Marshal-Lerner condition holds. On the other side however, recent theoretical developments proposed by the New Structuralist School of thought suggests several demand and supply-side channels through which real exchange rate undervaluations can adversely affect output in sectors. The latter school of thought proposes for instance that real undervaluations may hurt firms in sectors if they have foreign currency denominated debt.

Secondly, the few available sector-specific studies (Bhorat et al., 2014, Vaz and Baer, 2014, Masunda, 2012) have not adequately addressed endogeneity of the real exchange rate in sectoral growth regressions. It is widely acknowledged that the real exchange rate responds to macroeconomic factors that may also affect growth (Sallenave, 2010). On the other hand, the feedback effect of sectoral growth on the real exchange rate via the Balassa-Samuelson effect is worth taking into account when dealing with sectoral regressions (Rodrik, 2008). Combined together, the feedback effect and omitted third variables can surface a small sample bias that may not disappear asymptotically (Baltagi, 2008).

Thirdly, most of the sectoral studies have mainly focussed on the contemporaneous effect of exchange rate undervaluation on sectoral growth. This approach is limited in that undervaluation effects may take time to filter into the economy and show up in terms of growth. Such delayed effects may result from inertia effects or production contracts that may inhibit producers in sectors from instantaneously responding to macroeconomic changes. Also, the use of contemporaneous instead of lagged values of regressors may be flawed in that correlation does not equal causation. Using the latter in this regard would be helpful for policy issues as it partially addresses causal issues.

Taking the above limitations into account, this study contributes to the ongoing debate on exchange rate misalignment and economic growth by using a sectoral approach to shed light on the effects of exchange rate undervaluation on growth of 6 sectors at 2 digit level International Standard Industrial Classification (ISIC) in South Africa. While the study is aware that real exchange rate misalignment takes two forms namely undervaluation and overvaluation, it chooses to focus on the former since the effects of the latter are quite well known in the literature. An overvalued exchange rate is associated with currency crises, slow growth and macroeconomic imbalances (see for instance Rodrik, 2008). What remains unclear however; are effects of undervaluation on growth and this defines the overall purpose of this study. The sectors considered are agriculture, mining, manufacturing, tourism, financial and the personal services with data observed from 1985 to 2014. A sectoral approach has merit not only in addressing aggregation bias but also in allowing one to have a much clearer picture of how undervaluation relates to particular sectors of the entire economy.

Adding on to that, using a sectoral relative to the aggregate economy approach enables us to embrace the dual-economy characteristics. As Rodrik (2014) argues, aggregate economy growth theory does not suffice in describing growth dynamics in developing countries due to the failure to capture productive heterogeneity that exists across sectors. A sectoral approach that resembles dual-economy characteristics, i.e. tradable and non-tradables or goods and service sectors, therefore holds considerable promise since productivity heterogeneity continues to be a hallmark of most developing countries such as South Africa.

The second contribution of the study relates to the use of the Blundell and Bond system Generalised Methods of Moments (GMM) technique which is immune to the problem of regressor endogeneity. The Common Correlated Effects (CCE) estimator by Pesaran (2006) is also used to deal with of slope heterogeneity and existence of common correlated effects that are not directly observable. The only study we are aware of that used the CCE estimation technique in this literature is that of Karadam (2014) but it focussed on sub-industries in the manufacturing sector and not tradable sectors and, also, it was conducted in the Turkish context not the South African. These two estimation strategies common as they appear, are fairly novel in the literature of real exchange rate misalignment and economic growth at a sector level.

We contribute further by pinning down causal issues. Here, we focus on initial rather than contemporaneous values of the real exchange rate in our baseline regression. By using initial rather than contemporaneous values, we are able to ascertain how a change in undervaluation in the initial period correlates with subsequent growth. The merit of this approach lies not only in pinning down causal issues but also in capturing the potential delayed effects of undervaluation on sectoral growth. This approach is quite well known in cross-country regressions but is yet to receive much scholarly attention in the sectoral growth literature.

By using a sectoral approach to overcome aggregation bias, addressing causal issues using lagged values of exchange rate undervaluation and controlling for endogeneity and potential slope heterogeneity coupled with the presence of unobserved common correlated effects through the system GMM and CCE estimation techniques respectively, it is hoped that the findings of this study will settle, at least partially, the inconsistency of results across empirical studies.

To test whether the estimates are sensitive to the measure of exchange rate undervaluation, two measures of undervaluation are employed. The first measure is derived from the real exchange rate adjusted for the Balassa-Samuelson effect following Rodrik (2008). The second is computed from a model based approach in which the real effective exchange rate is undervalued if the prevailing rate is below the equilibrium level determined by the economic fundamentals. These measures of undervaluation are then used as regressors to appreciate how they relate to sectoral growth in a stepwise fashion.

In addition to using two measures of undervaluation, the results are also exposed to a battery of robustness checks which include the use of alternative estimation techniques particularly the fixed effects, random effects, pooled least squares, the augmented mean group (AMG) and the common correlated effects (CCE) estimator by Pesaran (2006). Time series techniques are further invoked in a bid to track the effects of undervaluation on the growth of particular sectors. An advantage of complementing panel evidence with time series is that the former solves the mystery of unobserved sector-specific effects but does not come up with sector specific policies while the latter is often confronted by issues of small data observations but is able to come up with sector-specific policies.

On the empirical front, a published piece of work that is close to ours is that of Njindan (2016) which sought to establish the effects of exchange rate undervaluation on sectoral performance in South Africa. Our study departs from that of Njindan (2016) in many respects. Firstly, relative to the standard growth regression used in Njindan (2016), our study examines the effect of undervaluation on sectoral growth in a neoclassical conditional convergence framework. This approach allows one to establish whether or not exchange rate undervaluation as a conditioning factor is able to determine where each sector heads in the long-run as it converges towards its steady state.

Also, instead of controlling for economy wide variables, our work probes the effect of real exchange rate undervaluation on sectoral growth while controlling for sector-specific input factors. The use of economy wide input factors is flawed in that factors of production may not be evenly distributed across sectors; this is critical in South Africa where labour absorption has largely been uneven across sectors (see for instance Rodrik, 2008).

Another distinction of our study is that Njindan (2016) tracked the effects of undervaluation on three individual sectors, namely the agriculture, industry and service sectors using time series techniques. In our study, we utilise a panel data approach which lumps together agriculture, mining, personal service, manufacturing, tourism and the financial sector. As compared to time series techniques, a panel data approach brings more diversity into the sample and at the same time affords us more degrees of freedom.

Lastly, Njindan (2016) employed a quantile regression estimator in computing undervaluation. Our work rather uses the Stock and Watson (1993) dynamic ordinary least squares (DOLS) approach. This approach accounts for the potential endogeneity problem emanating from the feedback effect (Balassa-Samuelson effect) and omitted variable bias. Unlike Njindan (2016) we first employ recent breakpoint unit root tests in computing our measure of undervaluation in order to solve the problem of potential structural breaks in data. The real exchange rate data series for South Africa is potentially plagued by structural breaks with the 1985 debt standstill, the 1995 Asian contagion effect and the 2000 inflation targeting regime being potential break-dates.

Another related piece of work that is worth mentioning is that of Masunda (2011) which isolated the effects of exchange rate undervaluation and overvaluation on the output of Zimbabwe's mining, manufacturing and agriculture sectors. Our study is different in that Masunda (2011) partly due to data constraints, considered only three sectors namely agriculture, mining and manufacturing. The availability of data for South Africa allows our work to increase the number of sectors to six by adding the tourism, financial and personal service sectors. The inclusion of these sectors is merited on the grounds of bringing sample diversity given the consideration of both tradable goods sectors and tradable services sectors.

Most importantly, Masunda (2011) relied on the Feasible Generalised Least Squares (FGLS) approach which does not adequately address endogeneity issues that emanate from third variables nested in the error term. Apart from third variables in the error term, growth of tradable sectors also has a feedback effect on the real exchange rate. The FGLS in this case will solve issues of endogeneity emanating from unobserved heterogeneity (sector-specific effects) and regressors, unfortunately leaving room for parameter bias and inconsistency that results from its inadequacy to address reverse causation and endogeneity of third variables in the stochastic error term (Baltagi, 2008). To address these attendant estimation problems, this paper employs the Blundell and Bond GMM technique; an estimator which is immune to such endogeneity issues.

Another novel feature of this study is the use of panel techniques, panel time series techniques and time series techniques to unravel the effects of real exchange rate undervaluation on growth of tradable sectors. For panel techniques, we use low frequency data, 5-year averages in particular to remove cyclical effects and short-run noise in data and the system GMM technique designed for panels with small time dimensions.

Panel time series on the other hand allows us to use relatively high frequency data, annual observations and solve the important problem of panel non-stationarity (given the presence of a relatively large time dimension that comes from using annual observations instead of 5-year averages) using recent panel unit root techniques. For this purpose, the study employs in addition to others, a fairly recent second generation panel stationarity test proposed by Pesaran (2007) to establish the underlying data generating process while controlling for potential cross sectional dependency across sectors. Consequently, testing for panel stationarity leads us to yet another contribution of using a recent test for cointegration developed by Westerlund (2007) to establish presence of a long-run relationship among the variables. Relative to conventional and common cointegration tests, the test proposed by Westerlund (2007) is chiefly based on structural as opposed to residual dynamics and therefore does not impose any common-factor restriction.

The study then employs, in addition to the Panel Dynamic Ordinary Least squares (PDOLS), the Fully Modified Ordinary Least squares (FMOLS) and the Pooled Mean Group (PMG), two recent estimation techniques, the Augmented Mean Group (AMG) introduced in Eberhardt and Teal (2010) and the Common Correlated Effects estimator to relax the conventionally held assumption of slope homogeneity in the cross-sectoral growth process.

1.2 Objectives of the Study

The primary aim of this study is to establish whether real exchange rate misalignment had an influence on the growth of tradable sectors in South Africa between 1985 and 2014 (a period dictated by data availability). Theory suggests that real exchange misalignment comes in two forms namely overvaluation and undervaluation. Since the effects of overvaluation are quite well known in the literature, this study will specifically focus on undervaluation. To this end, the study seeks to address the following specific objectives.

- To measure the degree of real exchange rate undervaluation in South Africa between 1985 and 2014
- To establish how the computed measure of real exchange rate undervaluation affects the growth of tradable sectors

1.3 Research Questions/Hypotheses

The study intends to test the following null hypothesis:

- Real exchange rate undervaluation has no effect on growth of tradable sectors.

The first specific objective does not have a research hypothesis because the objective is simply to compute the measure of undervaluation that will be used as an explanatory variable in the sectoral growth regression.

1.4 Significance of the Study

Academic Significance/Vacuum Filling – Although the relationship between real exchange rate undervaluation has received considerable attention among academics and policymakers; there is scanty literature that focusses on how undervaluation affects the growth of particular sectors. We focus on South Africa because the evidence in developing countries is not definitive; most studies find a positive relationship while some have failed to detect any such empirical link. In this inconclusive literature, no study in the South African context has combined results from panel data approaches and those of time series techniques at the 2 digit level. We also know of no study that has conducted a sector-specific analysis on a single country basis while simultaneously addressing the problems of endogeneity, reverse causation, potential slope heterogeneity and structural breaks in data.

With this in mind, we improve the existing stock of knowledge by applying recent estimation techniques such as the Common Correlated Effects (CCE) and the Augmented Mean Group (AMG) that address the potential existence of slope heterogeneity and common unobserved shocks. Unlike related empirical literature in the South African context, we pay special attention on the data generating process by taking into account measures that accommodate structural breaks in data so as to avoid erroneous inferences. Lastly, our study pioneers the combined use of panel data and time series techniques in South Africa for robustness purposes.

Policy Relevance – Given the relevance of the real exchange rate as an allocator of resources in a small open economy, the results of this study will determine the appropriate exchange rate policy for South Africa, which is essentially redirecting the current exchange rate arrangement towards one that promotes sectoral growth. The need for the South African government to promote growth in key sectors of the economy on the other hand warrants a study which rigorously examines how inappropriate exchange rate policies relate to sectoral performance.

The sectoral approach used in this study, which is quite novel, will also be useful to policymakers in designing sector-specific policies based on the sensitivity and vulnerability of each sector to exchange rate misalignment. Aggregated studies are generally criticised on the grounds of making blanket policies which do not take into account the differences that exist among sectors of the economy. Given that South Africa has been experiencing an economic slowdown on the back of a depreciating exchange rate since 2011 (Bank, 2015), the results of this study will provide an insight into how the economic competitiveness of the country can be revived and how growth in tradable sectors can be enhanced.

The study focusses on tradable sectors which are in many ways important for a developing country like South Africa. First, tradable activities possess some features that makes them instrumental in the process of growth. These features include the spill-over mechanisms that links economic sectors with the rest of the economy through forward and backward linkages. In fact, as demonstrated in Rodrick (2014a), tradable sectors such as agriculture provide important raw materials as inputs to the manufacturing sector. Some of the tradable sectors such as manufacturing sector also are able to absorb significant quantities of unskilled labour, something that sets them apart from other high-productivity sectors. Third, tradable sectors do not face the demand constraints of a home market populated by low-income consumers. They can expand and absorb workers even if the rest of the economy remains technologically stagnant. Taken together, these features make tradable sectors the quintessential escalator for developing economies and therefore focussing on sources of their growth goes a long way in promoting overall economic performance.

1.5 Thesis Outline

The study is divided into 6 main chapters. Chapter 1 gives the background, problem statement and objectives of the study, Chapter 2 provides an overview of the South African economy; in particular, macroeconomic developments in South Africa as well as sectoral performance (section 2.1) and exchange rate developments since the breakdown of the Bretton Woods system (section 2.2).

Chapter 3 then outlines and discusses the conceptual framework of the study. It is in this chapter that key theoretical concepts on real exchange rate misalignment particularly undervaluation and growth are conceptualised. Particular focus is directed to measuring real exchange rate misalignment in section 3.1 while sub-sections 3.1.1, 3.1.2 and 3.1.3 detail the purchasing power parity, black market premium and model based approaches respectively as measures of real exchange rate misalignment. In the same chapter, sub-section 3.2 outlines the theoretical literature while 3.3 reviews related empirical literature.

Chapter 4 outlines the analytical framework of the study. Data description is given in the introductory section 4.1 followed by the theoretical framework in section 4.2. Empirical models are then specified in 4.3, followed by the estimation strategy of the specified models in 4.4. Section 4.5 then outlines all relevant diagnostic tests performed while robustness checks and time series techniques are presented in sections 4.6 and 4.7 respectively. Chapter 5 presents, interprets and discusses the empirical findings of the study. In this respect, the introductory section, 5.1 tabulates the descriptive statistics of the data, followed by econometric estimates in section 5.2. Sections 5.3 and 5.4 present estimates from alternative strategies particularly panel time series and time series techniques. Chapter 6 then summarises the entire study and sets out policy implications. Suggestions for further study are also outlined in chapter 6 under section 6.4.

1.6 Definition of Key Terms

Real Exchange Rate – In this study, the theoretical definition of the real exchange rate is that of the relative price of tradable goods to non-tradable goods in a neoclassical sense. This can be described as an internal real exchange rate. Since the prices of tradable and non-tradable goods are not easily available, two proxies of the real exchange rate are considered in this study. The first is borrowed from Rodrik (2008) and defines the real exchange rate as the ratio of the value of the local currency in terms of the United States dollar to the purchasing power parity. The second is the real effective exchange rate which is essentially the domestic price index in South Africa in relation to the price index of its main trading partners multiplied by the nominal exchange rate of the South African economy. These two proxies are measures of economic competitiveness as they link domestic productivities to the world economy.

Undervaluation – In this study, two measures of exchange rate undervaluation are used. The first baseline measure is proposed by Rodrik (2008) while the second one is derived from a model based approach following Edwards (1988). The former measure is defined as the ratio of the value of the local currency in terms of the foreign currency to the purchasing power parity adjusted for the Balassa-Samuelson effect. The second measure observes an undervalued real exchange rate if the actual or the prevailing real exchange rate is below the equilibrium real exchange rate. The challenge of this later approach however is that the equilibrium real exchange rate is not directly observable and can only be determined empirically by econometric methods.

Tradable Sectors – The conventional approach of classifying sectors into tradable and non-tradables is based on whether or not a sector belongs to a goods sector or a service sector. Goods sectors such as mining, agriculture and manufacturing were therefore considered tradable while all service sectors were considered non-tradable. As Gehringer (2013) argues however, this approach is fast becoming less useful taking into account the growing importance of service sectors in international trade.

The realisation of how important service sectors are fast becoming in the international trade realm has led to the adoption of an approach suggested by De Gregorio et al. (1994). This approach considers a sector tradable if it exports more than 10 per cent of its output. The authors admit however that this classification is sensitive to the 10 per cent arbitrary threshold. Driven by the need to include sector diversity in the sample in our case, we consider every sector that exports at least part of its GDP. Data from Statistics South Africa in table 1.1 indicates that the mining, agriculture, manufacturing, tourism, community services (community social and personal services and personal service sector are used interchangeably) and the financial sector were actively involved in international trade during the sampling period (1985 – 2014).

Table 1.1: Sector Tradability in South Africa (1985 – 2014)

Sector	Rank	Export-Output Ratio (%)
Mining	1	77.8
Manufacturing	2	28.3
Agriculture	3	19.7
Tourism	4	4.3
Financial	5	5.3
Community social and personal services	6	1.7

Source: Statistics South Africa (2015)

Balassa-Samuelson Effect – this is a concept developed by Balassa (1964) which postulates that productivity growth in tradable sectors versus the non-tradable sectors due to technological advancement leads to real exchange rate appreciation by stimulating demand in the non-tradable sectors. The challenge for the researcher however, lies in finding an appropriate proxy variable for technological advancement.

Earlier studies, such as Ghura and Grennes (1993) captured the Balassa-Samuelson effect by a simple time trend. Others such as Razin and Collins (1997) proxied the Balassa-Samuelson effect by growth of GDP per worker. Recent studies mostly use gross domestic product (GDP) per capita growth rate. None of these proxies is without its own limitations but Toulaboe (2006) asserts that rapid growth in GDP per capita is closely associated with technological advancement. In this study therefore, the Balassa-Samuelson effect is proxied by the growth rate in GDP per capita. We particularly control for this effect by regressing our real exchange rate variable against the growth rate of GDP per capita.

CHAPTER 2

AN OVERVIEW OF THE SOUTH AFRICAN ECONOMY

The previous chapter presented the background of the study, problem statement, research objectives and significance of the study. This chapter provides an overview of the South African economy with the objective of having an understanding of economy-wide developments and sectoral performance in South Africa during the sampling period. The chapter is organised into two main sections.

Section 2.1 outlines economy-wide developments and sectoral performance respectively in South Africa. The entry point covers macroeconomic developments and the rationale of doing so is to first understand evolution of economic performance at a much broader level before zooming in to track performance at sectoral level. The sectoral performance section covers all sectors that are considered in the empirical analysis of the study.

Subsequent to the review of macroeconomic developments, section 2.2 provides a historical overview of the evolution of exchange rate policies and exchange rate movements in South Africa. This section is important in the sense that it enables us to understand how distinct exchange rate policies and regimes have shaped movements in the exchange rate in terms of depreciation and appreciation. Section 2.3 will then summarise the chapter contents.

2.1 Macroeconomic Developments and Sectoral Performance in the South African Economy

The South African economy is vital in the global mining and regional retail, finance and automobile value-chains. Both the financial and retail services are among the most sophisticated sectors in Sub Saharan Africa with a large significant presence in the Southern African Development Community (SADC). In the services sectors, the finance and real estate and insurance are at the forefront with retail and finance in particular fast tapping into more dynamic growth of the SADC region. Owing to such sectoral developments, the economy of South Africa has capitalised more on these service sectors as major drivers of economic growth.

Historically at a macroeconomic level, economic growth in South Africa has been fluctuating since the democratic government of South Africa came to power in 1994 (see figure 1.1). Upon inheritance of the economy from the apartheid regime, the government of South Africa was faced by a myriad of socio and economic challenges that ranged from high unemployment, widespread poverty, and income inequality to poor access to health care facilities and education. Growth was chiefly held back by capital controls, political isolation and economic sanctions that marginalised South Africa from the global world. In this respect, economic expansion was constrained by falling investment, high inflation and weak public finances. The new government in response, engaged in a number of policies to enhance economic activity and raise the overall standards of living. Consequently, economic growth grew at an average of 3 per cent between 1995 and 2003 which was almost double the average growth posted between 1980 and 1994 (Njindan, 2016).

The source of this growth can be traced to two factors. The first includes strides that were taken by the new government to strengthen public finances in a bid to create a stable financial environment. Secondly, the increase in economic performance was attributed to the integration of the South African economy into the world economy. The latter came along particularly with trade reforms and the removal of political sanctions. Heightened fiscal discipline accompanied this turnaround in economic activity and in particular the tax regime was made much more competitive coupled with cautious and sustainable social spending. By 2003, the government had successfully managed to lower public borrowing to 1 per cent of total GDP down from a peak of 9 per cent in 1994 (Bank, 2015).

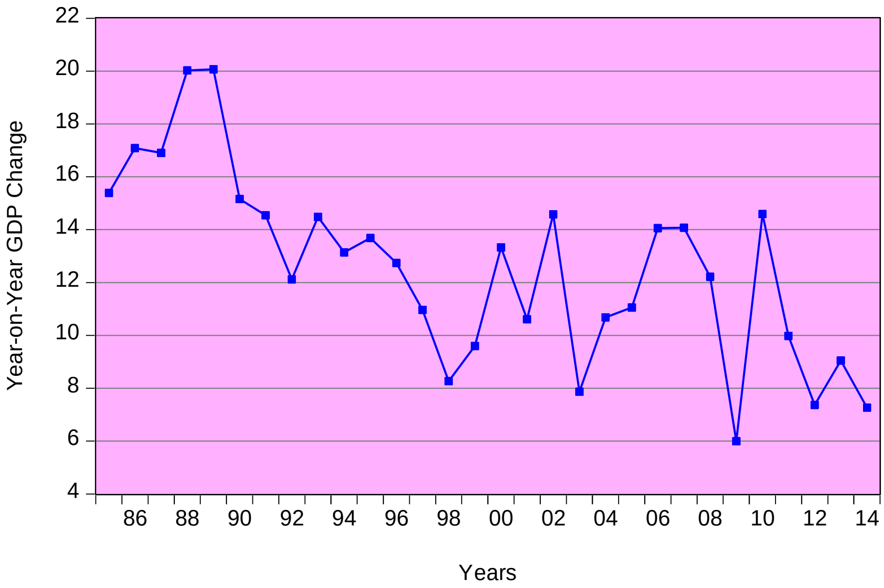


Figure 1.1: GDP Growth in South Africa (1985 – 2014)

Source: Author's Computation using data from IMF Financial Statistics

In 2000, the monetary authorities announced the introduction of a new monetary arrangement; inflation targeting in which the authorities would target inflation rather than the exchange rate. Under inflation targeting, the authorities set a target and announce it to the public.

The credibility of the monetary policy improved and inflation expectations were anchored within the auspices of inflation targeting. Relative to the apartheid era, South Africa enjoyed low rates of inflation post inflation targeting. Low rates of inflation were not only attributed to the inflation targeting regime but were also a result of improved fiscal reforms that were supportive of anti-inflation in the economy. Improvements in fiscal activities were reflected in reduced budget deficits. On the other hand, to avoid the ballooning of debt, deficit financing operations were financed without borrowing from the local central bank.

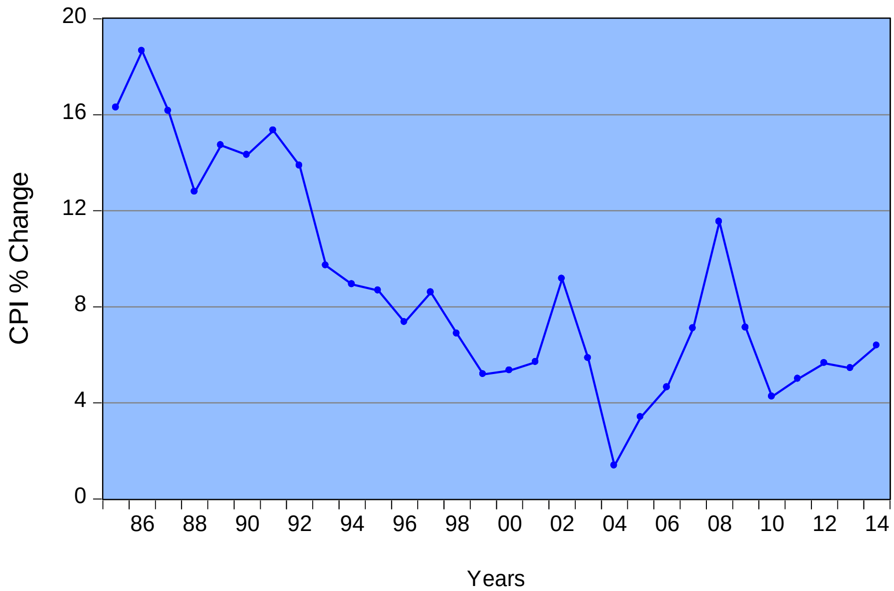


Figure 1.2: CPI in South Africa (1985 – 2014)

Source: Author's Computation using data from Statistics South Africa

Recent years have however seen inflation on an upward trajectory owing mainly to the weakening of the rand and other supply side factors such as drought (see figure 1.2). Economic growth has been less impressive as well with annual growth failing to exceed the level of growth experienced prior to the 2008/09 global financial crisis. This pattern is however true for many other developing countries and emerging markets in the wake of falling global commodity prices and the threat coming from rising interest rates.

Since 2011, South Africa's gross domestic product has generally trended downwards, albeit steadily reflecting both cyclical and structural impediments. The economy's potential growth has lowered to 1.5 per cent below half long-run averages owing to cyclical factors and structural slowdown (SARB, 2016). The recently issued monetary policy statement (the Monetary Policy Review October 2016) suggests that the ongoing slowdown in economic growth has proven to be unusually persistent. No other period in the past 20 years has witnessed such a slow average rate of growth.

Two central forces that accompany this low prevailing average growth rate are weak domestic demand and declining potential growth which has fallen from a peak of 4 per cent to only 1.4 per cent in 2016 (SARB, 2016). In addition to these two, growth in South Africa is also held back by low domestic savings. This has meant that domestic investment has been financed mostly by imported savings which makes the economy susceptible to external shocks such as the sudden change in the global financial conditions.

On the back of these macroeconomic impediments, growth in the first quarter of 2016 was in negative territory, -1.2 per cent, with the agriculture sector contracting hugely owing to recurrent droughts (SARB, 2016). In the second quarter, economic growth climbed by 3.3 percentage points with the mining sector adding 0.8 percentage points while the manufacturing sector added a 1 percentage point to this growth rebound. The latter was the result of increased vehicle exports (SARB, 2016). Despite this growth rebound however, the problem of weak demand still constrains further growth and net exports continue to serve as the main driver of growth on the back of prolonged currency depreciation that has nonetheless showed signs of slight appreciation recently.

The local currency, the rand, has slightly appreciated although the latest Monetary Policy Review claims that the currency remains significantly undervalued. In June 2016 for instance, SARB (2016) figures suggest that the real effective exchange rate (REER) was undervalued by 17 per cent relative to the 20 year average of the Bank’s index which accounts for producer price differentials and 24 per cent undervalued relative to the index which takes into account the consumer price index differentials.

With respect to sectoral performance, the contribution of agriculture to South Africa’s total GDP is relatively low, around 2.6 per cent given that the economy has been moving from primary production towards the tertiary sector (Ramaila et al., 2011). The 2015 quarterly bulletin by the South African Reserve Bank indicates a 5.7 per cent contraction of the agriculture sector in 2015 owing to recurring droughts which weighed heavily on maize and wheat production. Despite the drought induced contraction, several agricultural commodities have enjoyed rapid export growth as local farmers are taking advantage of the weakness of the rand to expand markets. Figure 2.1 shows the evolution of year on year growth in the agriculture sector. A visual inspection of the graph reveals a fluctuation of growth with two major dips in the early and mid-90s.

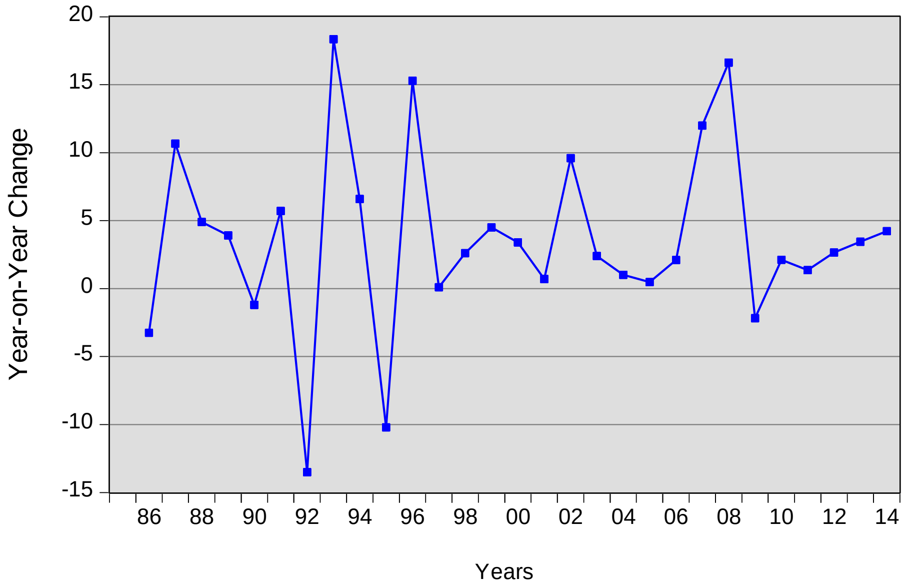


Figure 2.1: Agriculture Sector Growth (1985-2014)

Source: Author's Computation using data from Statistics South Africa

The contribution of the manufacturing sector is relatively small, 15 per cent of overall GDP accounting for 13.3 percent of formal employment (Zalk, 2014). The automotive industry plays an integral role in the performance of the overall sector accounting for 10 percent of the country's manufactured exports, contributing 7.5 percent to GDP and employing around 36,000 workers (Zalk, 2014). The performance of the manufacturing sector in South Africa remains curtailed however by the sluggish growth of demand in the country's main export markets particularly in developed countries. The annual growth of the sector has over the years been close to zero (see figure 2.2).

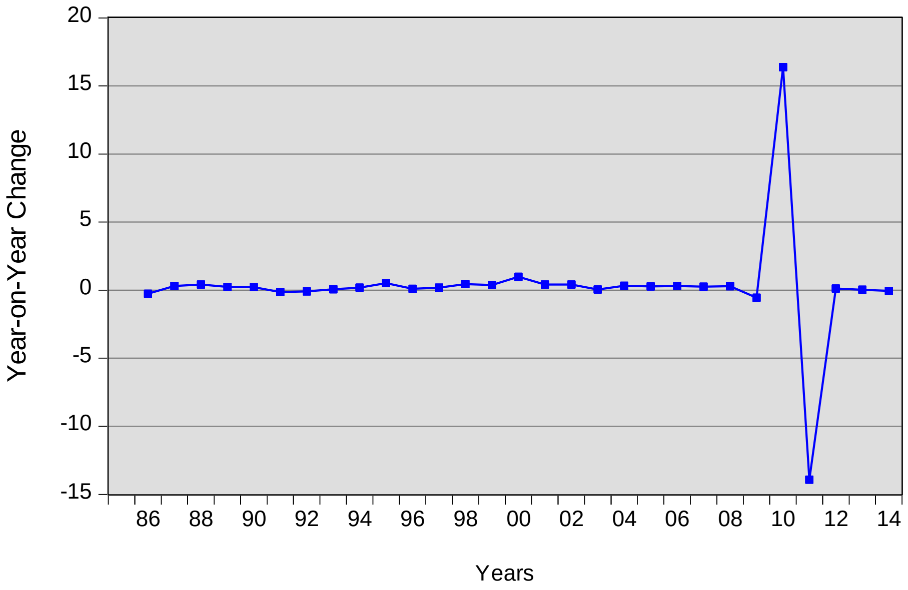


Figure 2.2: Manufacturing Sector Growth (1985-2014)

Source: Author's Computation using data from Statistics South Africa

Growth in the manufacturing sector stagnated in 2015 although the performance was widely spread across subsectors. For instance, positive growth rates were posted in subsectors that exported on the world market with the help of the rand depreciation. Such sectors include dairy, electrical machinery, motor vehicles, beverages and grains. In contrast, growth in the steel subsector, which constitutes about 19.6 per cent of total manufacturing output, plummeted reducing growth of the entire sector by 0.6 percentage points (SARB, 2015). Against the backdrop of subdued growth, the manufacturing sector witnessed in 2015 a drop in employment with job losses being largely recorded in basic metals, wood and paper products. Electricity shortages and weak demand continue to weigh heavily on growth of the manufacturing sector.

South Africa's mining sector contributed 4.9 per cent towards GDP in 2013 (Antin, 2013). Recently statistics by SARB (2015) suggests that the value added of the mining sector in real terms improved by 4.5 per cent during the first half of 2015 although growth varied across subsectors. Much of this improvement was spurred by the recovery of the platinum subsector from prolonged strikes in 2014. On the other hand, growth in the coal, iron ore and gold subsectors was held back by falling commodity prices and escalating domestic production costs. Annual growth in the mining sector has hovered up and down since 1985 with an annual growth peak being witnessed in the mid-90s (see figure 3.1). The 2008/09 global economic recession also dealt a huge blow to annual growth of the sector.

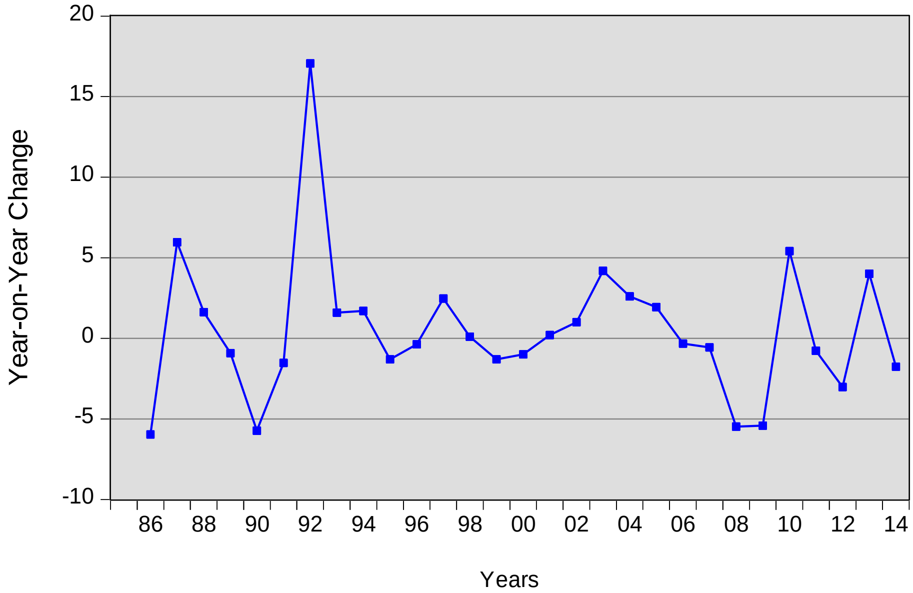


Figure 3.1: Mining Sector Growth (1985 – 2014)

Source: Author's Computation using data from Statistics South Africa

The weakening of the rand in the recent years has had a cushioning effect on mining exporters but low global commodity prices coupled with rising production costs in the domestic economy contributed largely to the 1.6 per cent employment drop in the mining sector (SARB, 2015).

South Africa's financial sector on the other hand is well developed and consists of 30 banks with close to 4000 branches (SARB, 2015). The importance of financial services has been growing over the years given the transition of the South African economy from relying on goods sectors to service sectors. In South Africa, financial activities are recorded under finance, real estate and business services constituting 21.5 per cent of total GDP (SARB, 2015). Figure 3.2 tracks annual growth in South Africa financial sector between 1985 and 2014.

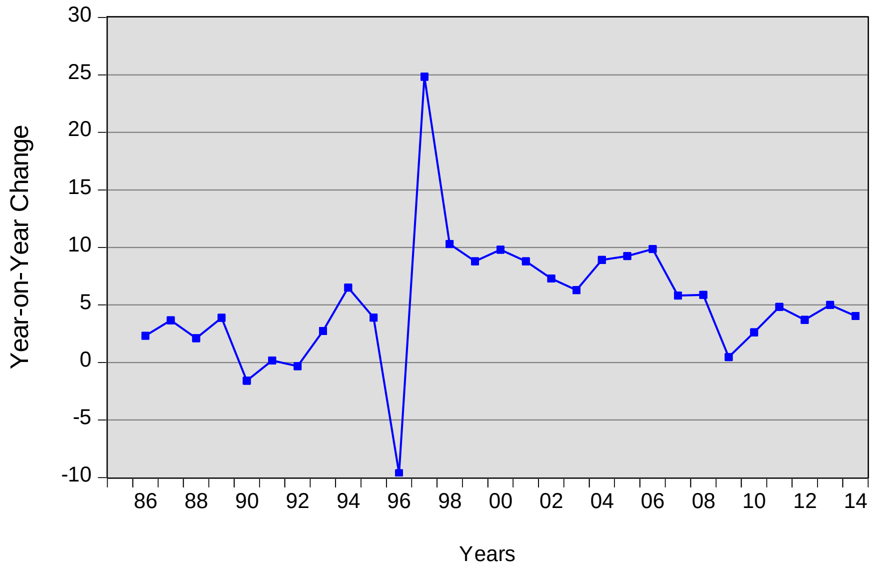


Figure 3.2: Financial Sector Growth (1985 – 2014)

Source: Author's Computation using data from Statistics South Africa

Output in the financial service sector grew by 1.7 per cent in the first half of 2015 emanating from improvements in banking and securities activities (SARB, 2015). Financial services combined with business services, wholesale and trade contributed to a 0.7 per cent boost in employment subsequent to a 2 per cent increase recorded in 2014 (SARB, 2015).

Tourism services fall under trade, catering and accommodation accounting for about 12.5 per cent of total GDP in 2013 (SARB, 2015). The tourism sector plays a significant role within the economy of South Africa. The sector is an important source of government revenue accounting for 4.4 per cent of the total employment in South Africa. As figure 4.1 shows, the tourism sector was hard-hit by the 2008/09 global recession before picking up in 2011 thanks to the 2010 soccer world cup tournament that boosted tourism activities particularly accommodation.

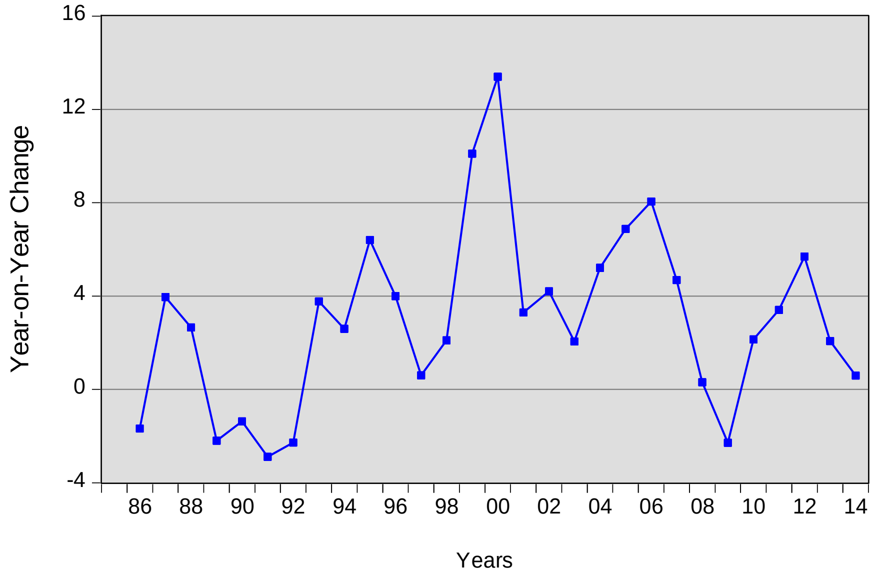


Figure 4.1: Tourism Sector Growth (1985 – 2014)

Source: Author's Computation using data from Statistics South Africa

Tourism activities are expected to grow on the back of a weakening rand although weak global and domestic demand continue to have negative effects on growth prospects of the sector. The personal service sector accounts for about 4.5 per cent of total GDP employing 2 463 000 employees (StatsSA, 2014). From figure 4.2, it is apparent that annual growth in personal services trended upwards after the end of the apartheid regime in 1994 although growth seems to have been nose diving particularly prior to the 2008/09 global recession.

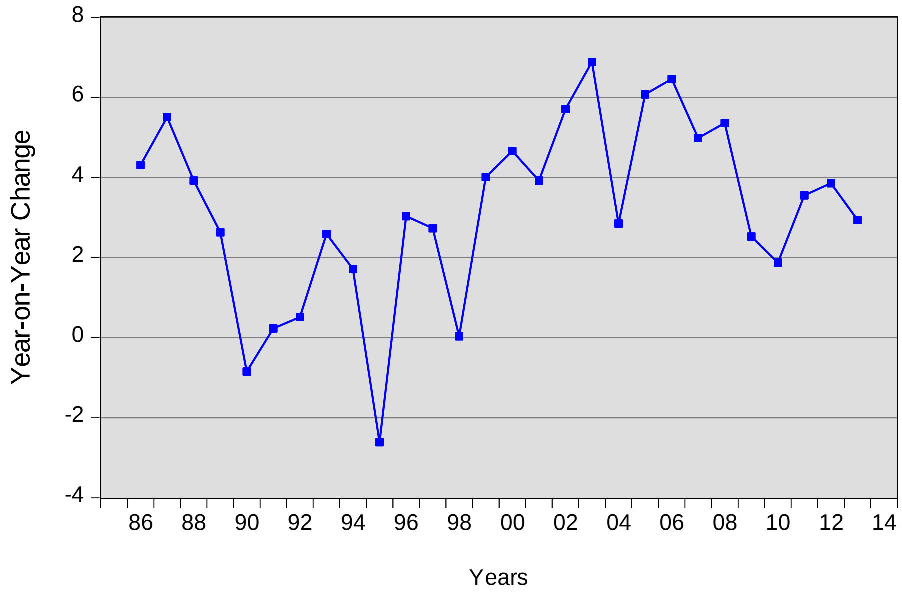


Figure 4.2: Personal Service Sector Growth (1985 – 2014)

Source: Author’s Computation using data from Statistics South Africa

The next section provides an outline of the evolution of exchange rate policies in South Africa post breakdown of the Bretton Woods system. The section focusses on both the nominal and real exchange rate movements although the empirical analysis of the study is mainly interested in the real rather the nominal exchange rate.

2.2 Exchange Rate Developments in South Africa

Like any other price in the economy, exchange rates can be determined either by market forces (demand and supply) or administratively. At one extreme, an economy can operate a free floating exchange rate policy where forces of demand and supply in the market take care of the prevailing exchange rate. Under a free floating exchange rate regime, monetary authorities have no direct influence on the exchange rate. At the other extreme is the fixed or pegged exchange rate policy where authorities fix the exchange rate. This was the case, for instance, under the regime of the gold standard before 1914. A wide variety of other exchange rate arrangements can however be found in-between these two extremes regimes.

One can divide the evolution of exchange rate policies in South Africa into five periods which are 1) 1945 –1971, an era of pegged rates under the Bretton Woods system of pegged but adjustable exchange rates 2) 1971 – 1979 which marked the disintegration and collapse of the Bretton Woods system, 3)1979 –1985, which was a period characterised by considerable reforms by monetary authorities aimed at promoting a market for foreign exchange rate and a flexible/floating exchange rate regime, 4) 1985 – 1999, where authorities sought to revert back to direct control measures to achieve exchange rate stability, and 5) 2000 onwards where the monetary authorities have targeted inflation and do not directly intervene in the market to determine the exchange rate.

Prior to 1970, the South Africa rand (ZAR) was pegged against the pound Sterling (Reinhart and Rogoff, 2002). The collapse and disintegration of the Bretton Woods system of pegged rates in 1971 put pressure on local authorities to adjust the exchange rate policy. Because South Africa's foreign exchange market, was then less robust and relatively underdeveloped to operate a free floating regime, the Reserve Bank opted to peg the rand against the United States (US) dollar instead of the British Pound. In December 1971, as part and parcel of the realignment of the exchange rates, the ZAR got devalued by 12.3 percent (Van der Merwe, 1996). In 1972 towards the end of the second quarter, the pound floated downwards in relation to currencies of major trading partners and as a coping strategy to ensure and maintain the momentum of balance of payments (BOP) recovery, South Africa decided to link the ZAR to the Pound. This move was however short-lived as the Rand was pegged once again to the US dollar in October 1972.

The move back to pegging the ZAR to the US dollar saw a 3 percent appreciation of the ZAR (Van der Merwe, 1996). In February 1973, the US dollar witnessed a 10 percent devaluation but South African authorities did not follow suit because of a sound BOP position and the overall macroeconomic environment that was conducive to growth (Eun et al., 2012). In 1974, the South African Reserve Bank (SARB) announced that a managed floating policy was to be pursued in an effort to closely reflect the dynamics of the country's BOP and the domestic macroeconomic situation. In line with this policy, frequent but small exchange rate adjustments were enforced which kept the ZAR's nominal effective exchange rate (NEER) fairly stable between 1974 and 1975.

The policy of managed floating worked fairly well up until the end of the first quarter of 1975 when the strengthening of the dollar coincided with the weakening of the pound Sterling. These events (the strengthening of the dollar and the depreciation of the pound Sterling) spurred fears among economic agents and raised expectations that the ZAR would be adjusted downwards in relation to the US dollar. This encouraged local importers to promptly pay for their imports while exporters retained their exports proceeds abroad for prolonged periods of time.

Against this background, the SARB decided to change their exchange rate regime with effect from June 1975 and to maintain a constant ZAR-dollar for a prolonged period of time adjusting whenever necessary. This policy development was grounded on a ZAR-dollar rate of $1.40 per ZAR which implied a 4.76 per cent depreciation of the ZAR (Van der Merwe, 1996). The dollar continued to appreciate and consequently, the ZAR strengthened. By the end of the third quarter in 1975, South Africa's BOP position had considerably deteriorated and this necessitated the measures that would ultimately prevent a concomitant decline in the country's economic growth but rather spur improvements in the BOP position. Under such circumstances, the ZAR was devalued by 17.9 per cent on 22 September 1975 (Eun et al., 2012). This link between the ZAR and the dollar persisted up until the first quarter of 1979.

Various other measures were implemented between 1979 and 1980 in an effort to establish a much freer floating exchange rate for the ZAR. Of these measures, the first was introduced in February 1979 when the SARB ceased announcing its predetermined buying and selling rates in advance. The next measure was marked by the Finance Minister's announcement that; ''In future, the market forces will play a huge role in the determination of the rand'' (Van der Merwe, 1996).

The termination of the fixed exchange rate regime in 1979 thus gave birth to the dual exchange rate system (spot and forward exchange rate market) which was short-lived as it was abandoned in February 1983. Outright floating of the exchange rate commenced later in October 1983. In particular, the Finance Minister announced the introduction of new measures to enhance the functioning of the forward and spot exchange rate markets. On the back of these efforts, the rand depreciated sharply owing to the drop in the dollar price of gold and massive capital outflow emanating from political instability combined with the effects of the debt standstill that transpired in 1985. These developments triggered tighter foreign exchange rate controls by the South African Reserve Bank (SARB).

Between 1986 and 1993, MacDonald and Ricci (2004) note that the rand appreciated rapidly rising from an index of 81 to 111.04 on the back of falling inflation. In the immediate aftermath of this strong and prolonged appreciation, the rand weakened from over 110 to 71 in 2001 (Ziramba, 2013). In 1998, South Africa's real effective exchange rate (REER) suffered a huge blow from the Asian contagion effect with the rand weakening by 20 percent in relation to the dollar (Bank, 2015). In response, the SARB raised the interest rate as an indirect effort to strengthen the Rand (Karoro et al., 2009). Nonetheless, continued sentiments towards emerging markets saw the continued weakening of the Rand against the dollar with the nominal effective exchange rate (NEER) depreciating by more than 20 percent in 2001 (de Jager, 2012) (see figure 5.1).

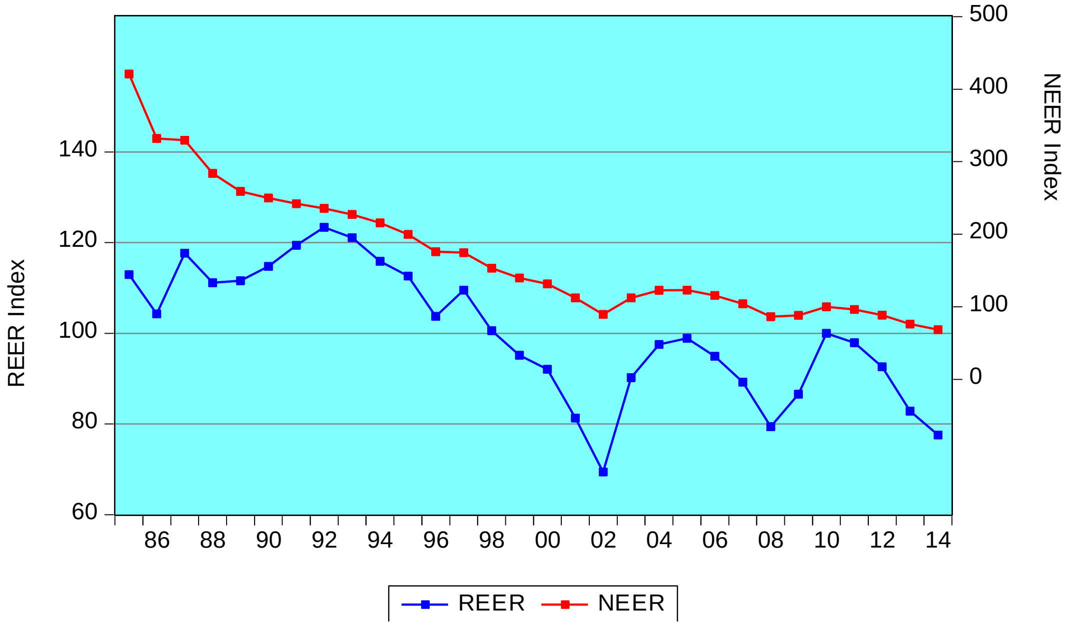


Figure 5.1: REER and NEER in South Africa

Source: Author's Computation using data from Statistics South Africa

Subsequent to the 2001 currency depreciation as apparent in figure 5.1, the South African rand recovered by a massive appreciation thanks to positive investor sentiments that boosted foreign exchange activities in the country. As displayed in figure 5.1, the nominal effective exchange rate appreciated by almost 24 percent in 2002. Although increased investor confidence largely contributed to the recovery of the ZAR, Bank (2015) claims that the appreciation of the nominal and real effective exchange rate was a result of economic fundamentals particularly the favourable commodity prices that boosted export activity and widening interest rate differentials as well as a robust current account position. In any case, the appreciation of the rand undermined export competitiveness and tradable sectors such as mining suffered a huge blow (Saayman, 2010). The loss of economic competitiveness pressurised the South African Reserve Bank (SARB) to intervene in the market in an effort to weaken the currency.

Consequently, the nominal effective exchange rate plummeted by 9 percent on account of falling commodity prices coupled with slashed domestic interest rates when global rates were actually rising (de Jager, 2012). The depreciation was a prolonged one as it lasted until 2009 when the slight but promising appreciation of the ZAR was unfortunately interrupted by the global recession. The real effective exchange rate (REER) fell from 90.78 in January 2007 to 77.55 in the fourth quarter of 2008 (Saayman, 2010). In the period post the 2009 Global recession, both the nominal and real effective exchange rates have generally been nose diving with Bank (2015) reporting that the ZAR has depreciated by 50 percent against the currencies of its major trading partners since 2011.

2.3 Chapter Summary

This chapter has provided an overview of the South African economy tracing the evolution of economic growth and related macroeconomic indicators such as inflation and growth in key sectors of the economy. Section 2.1 in particular traced recent developments in South Africa since the end of the apartheid. In the same section, the performance of key sectors in terms of output was also outlined. Section 2.2 then presented the evolution of exchange rate policies in South Africa since the end of the Bretton Woods system of pegged rates. In particular, attention focussed on evolution of the real effective exchange rate and nominal effective exchange rate as well as the shifts in exchange rate regimes by the monetary authorities in South Africa. The next chapter provides the conceptual framework of the study.

CHAPTER 3

CONCEPTUAL FRAMEWORK

The previous chapter reviewed macroeconomic developments, sectoral performance and the evolution of exchange rate policies in South Africa. This chapter provides the conceptual framework of the empirical analysis. The essence of this chapter is to identify key theoretical issues that are pertinent to the study and then conceptualise them in order to enhance one's understanding on how real exchange rate undervaluation affects sectoral growth. To this end, the chapter is organised into three main sections.

Section 3.1 first conceptualises measurement of real exchange rate misalignment. This section essentially focusses on different approaches to measuring real exchange rate undervaluation and overvaluation since the former will be used as the main variable of interest in the empirical analysis. Section 3.1 is further broken down into sub-sections 3.1.1 and 3.1.2 which briefly discuss the purchasing power parity, the black market premium approach and the model-based approach respectively as measures of real exchange rate misalignment.

Section 3.2 then reviews the theoretical literature and because of a lack of a unified theory that governs how the real exchange rate interacts with growth, the section will be largely based on pertinent theoretical arguments and propositions. Section 3.3 will then review related empirical literature while section 3.4 will summarise the chapter contents.

3.1 Measuring Real Exchange Rate Misalignment

3.1.1 The Purchasing Power Parity

The purchasing power parity (PPP) is one of the highly celebrated theories of exchange rate determination in literature. According to this theory, prices in a particular country must be equal to that of another country when expressed in a certain common currency. The PPP provides the simplest way to measure equilibrium real exchange rate. In this framework, the change in the bilateral exchange rate between the two currencies over a period of time is determined by changes in relative prices in the two countries.

It then measures misalignment as deviations of the real exchange rate from the parity in a selected year. Notwithstanding its simplicity, the PPP methodology has shortfalls in that it only accounts for monetary sources of exchange rates and neglects contemporary exchange rate fluctuations attributed to real factors. Also, another shortfall of the PPP approach is that it treats the real exchange rate as an immutable number yet in practice the real exchange rate responds to movements in economic fundamental variables.

3.1.2 Black Market Premium

Following the weaknesses of the PPP, economists have advocated the use of the black market premium approach as a measure of misalignment. In this framework, real exchange rate misalignment is defined as deviations between the parallel market and the official exchange rate. A high sustained premium is strongly argued to be a significant indicator of currency overvaluation thus serving as a useful proxy. The limitation of this measure is that it is sensitive to temporary shocks that may have little or no effect on the underlying fundamental real equilibrium exchange rate. Empirically, Ghura and Grennes (1993) confirm that this measure overstates the degree of real exchange rate misalignment.

3.1.3 Model-Based Approach

The recent and most used approach to measuring the equilibrium real exchange rate and its associated misalignment values is the model-based measure. This approach has its theoretical foundation in the so called dependent model developed by Swan (1956) where real exchange rate is defined as the relative price of tradable to non-tradable goods. This method involves the determination of fundamental factors that affect the real exchange rate. The long-run equilibrium exchange rate is then compared with the actual real exchange rate to come up with the misalignment measure.

The model-based approach can be subdivided into many other models such as the Behavioural Equilibrium Exchange Rate (BEER), Natural Equilibrium Exchange Rate (NATREX), Fundamental Equilibrium Exchange Rate (FEER) and the Desired Equilibrium Exchange Rate (DEER). These other approaches differ in the fundamental variables used as well as the time horizon. This study uses the FEER which is most appropriate in our case given the study period which is long enough to provide a long-run relationship unlike other approaches especially the BEER and NATREX which are generally appropriate in short to medium term horizons.

Needless to say, a thorough review of the literature indicates that these approaches are more complementary than they are competing. Using the FEER approach, a real exchange rate will be undervalued if the actual real exchange rate is more depreciated than the equilibrium real exchange rate while the converse holds for an overvalued real exchange rate. Thus for measurement of undervaluation and overvaluation, a model of equilibrium real exchange rate determination should be the entry point.

To measure the equilibrium real exchange rate, the study follows a model by Baffes et al. (1997) which assumes a small economy that is exposed to external competition producing and consuming two goods namely tradable and non-tradable. Aggregate demand for non-tradables is composed of private consumption (C_{NP}) and government consumption (C_{NG}). By letting C_P signify aggregate private spending (measured in tradables), θ as the spending that goes into traded goods, and Y_N as the total supply of non-tradables under the assumption of full employment of resources, the state of equilibrium in the non-tradable sector market can be expressed as:

$$Y_N\ (e) = C_{NP} + C_{NG} = (1 - \theta)e\ C_P + C_{NG} \qquad (1)$$

From this expression, $e = \frac{P_T}{P_N}$ the real exchange rate is theoretically defined as the price ratio of tradables to non-tradables P_T and P_N respectively. This measure of the real exchange rate describes and explain the internal exchange rate that allocates resources in the domestic economy across tradable and non-tradable sectors. A depreciated real exchange rate can, for instance, signal profitability in non-tradables which facilitates a movement of resources from the non-tradable sector towards the tradable sector.

With respect to the external environment, equilibrium is attained if a change in the long-run position of international reserves collapses to zero. This equilibrium can also be defined as the gap between the capital account and the current account. The current account balance in the model (Λ) is defined as the sum of 1) trade balance (τ), 2) net unilateral transfers and 3) (ν) and net investment income (κ). The trade balance component is expressed as the gap between the supply of tradables $(Y_T\ (e))$ and the sum of consumption on tradables in the private sector (θC_P) and government consumption on tradables (C_{TG}). Net investment income is then defined by the product of net foreign assets (F) and real yield on the foreign assets (r). External balance can be expressed as:

$$\Lambda = \tau + \nu + \kappa = Y_T\ (e) - (\theta C_P + C_{TG}) + \nu + rF \qquad (2)$$

Combining the first and the second equation, assuming external balance holds in the long-run, $(i.e\ \Lambda = 0)$, the real exchange rate (e^{*}) that equilibrates the non-tradable sector and the external sector can simultaneously be written as:

$$e^{*} = e^{*}(C_{NG}, C_{TG}, \nu + rF) \qquad (3)$$

For a small open economy like South Africa facing a binding credit ceiling, the trade balance can be treated as exogenous so that equation 3 can be re-expressed into the following form:

$$e^{*} = e^{*}(C_{NG}, C_{TG}, \tau) \qquad (4)$$

In order to arrive at the final equilibrium real exchange rate, we need to take into account the influence of an economy's terms of trade as well as the trade policies. For South Africa which is too small to influence world prices, the foreign price of exportables (P_x^{*}) and importables (P_m^{*}) is treated as exogenous determined. In this respect, the corresponding prices in the domestic economy are given by:

$$P_x = E(1 - t_x)P_x^{*}$$

$$P_m = E(1 - t_m)P_m^{*}$$

where t_x and t_m represent export and import tax rates respectively while E is the nominal exchange rate. The domestic relative price of exports and imports is given by:

$$\frac{P_x}{P_m} = \frac{(1 - t_x)}{(1 - t_m)}\frac{P_x^{*}}{P_m^{*}} = \frac{\varphi}{\lambda}$$

where:

$$\varphi = \frac{P_x^{*}}{P_m^{*}}, \lambda = \frac{(1 - t_m)}{(1 - t_x)}$$

The dynamics of terms of trade denoted (φ) and the trade policy (λ) will influence the real exchange rate for both the imports and exports. In addition to the fundamental variables in equation 4, one can view the equilibrium real exchange rate as a function of the trade policy and terms of trade variables which can be represented by:

$$e^{*} = e^{*}(C_{NG}, C_{TG}, \tau, \varphi, \lambda)$$

This model can also be improved by accommodating a technological progress variable (Γ) so that the final model is:

$$e^{*} = e^{*}(C_{NG}, C_{TG}, \tau, \varphi, \lambda, \Gamma) \qquad (5)$$

The fundamental variables represent mainly four economic stances and these are (1) domestic supply-side factors particularly the Balassa–Samuelson effect that arise from rapid productivity growth in the tradables sector relative to the non-tradables sector; (2) fiscal policy, such as budget deficits and the change in the proportion and composition of government expenditure between tradable and non-tradable goods, (3) the external environment that includes capital inflows, and terms of trade and 4) the country's commercial policy such as trade liberalisation in the form of a reduction in export subsidies and import tariffs.

Since our empirical framework is basing on a model developed by Rodrik (2008), we also employ Rodrik's measure of undervaluation. The first step is to define the real exchange rate.

$$\ln RER_t = \ln(XRAT_t / PPP_t)$$

where; *XRAT* and *PPP* denote the exchange rate and the purchasing power parity (PPP) respectively expressed as national currency units per United States (US) dollar. The PPP in this case refers to the number of units of the Rand required to purchase the exact amounts of goods and services as one US dollar would purchase in the United States of America.

There is however a distortion of the purchasing power that needs to be addressed in computing this measure of undervaluation. This distortion is known in the literature as the Balassa-Samuelson effect and it essentially describes the distortion in the PPP that arises from international price heterogeneity in the relative productivity between tradable goods sector and non-tradable goods sector. This distortion can either be assessed in level form or in evolution form. The Balassa-Samuelson effect in level form predicts that developing countries are characterised by relatively low productivity in the tradable goods than in the non-tradable goods – as is the case in many developing countries – have lower price levels than in other countries. In evolution terms, the Balassa-Samuelson effect describes a trend appreciation of the real exchange rate in countries undergoing a process of economic catching-up leading to productivity gains in tradable relative to non-tradable goods sectors.

For the greater part of our sampling period particularly starting from 1994, South Africa went through rapid development emanating from economic reforms by the new government post the apartheid regime. During the development process, productivity tends to increase more rapidly in the tradable goods sector than in the service sector. Given that the prices of tradable goods are generally exogenous, that is they are determined by the world market, an increase in productivity in this sector leads to an increase in wages. Since the increase in wages later spreads across the entire economy, there will be a rise in relative prices in the non-tradable goods sector where productivity is not likely to grow as rapidly.

Given that the overall price index (which is the internal real exchange rate defined as the relative price of tradable to non-tradable goods), there is going to be an increase in the prices of domestic goods as compared to those in the foreign market. This process results in an appreciation of the real exchange rate. This effect, the Balassa-Samuelson effect is a supply-side effect as it emanates from increased productivity in the tradable sector. There is also a possibility of an exchange rate appreciation from the demand-side emanating from what is called the Baumol-Bowen effect.

The Baumol-Bowen effect also provides an explanation that is similar to the Balassa-Samuelson effect. It explains the rise in the relative prices of non-tradable goods by introducing consumer demand given that the income elasticity of demand for services exceeds that of demand for goods. In this case, the share of services in demand increases during the process of development and the relative price increase of services results in an appreciation of the real exchange rate. Most studies seem to focus more on the Balassa-Samuelson effect for two main reasons 1) being that the Balassa-Samuelson was observed first and 2) because both concepts yield similar effects on the real exchange rate.

Either way, the puzzling and important aspect relates to finding an appropriate proxy for the Balassa – Samuelson effect. As mentioned earlier, in this study we use growth rate of real GDP per capita. In this regard, controlling for the Balassa Samuelson effect requires, in the second step estimation of an equation in which the real exchange rate is regressed against growth of real gross domestic product per capita. Undervaluation is then defined as the deviation of the actual real exchange rate from the Balassa Samuelson adjusted rate as follows:

$$\ln UNDERVAL_t = \ln RER_t - \ln \widehat{RER}_t$$

where $\ln \widehat{RER}_t$ is the predicted value of the real exchange rate. A value above unity indicates an undervalued currency which makes goods produced domestically relatively cheaper in terms of the dollar. On the other hand, a value less than unity will signify an overvaluation of the local currency in dollar terms. The next section presents pertinent theoretical literature.

3.2 Theoretical Literature

A number of explanations have been proposed in the literature as to how exchange rate over/undervaluation may affect growth. For Ebaidalla (2014), exchange rate misalignment captures the consequences of distortionary monetary and exchange rate policies on the allocation of resources between exporting sectors and import competing sectors. It affects sectoral growth through a number of channels. Firstly, an overvalued exchange rate results in a loss in economic competitiveness of export and import competing sectors within an economy. Since the real exchange rate is a relative price, its overvaluation would make it difficult to sell in a foreign market and this can compromise growth of tradable sectors which mainly produce for the foreign market (Razin and Collins, 1997). In the context of South Africa, tradable sectors such as agriculture, mining and manufacturing are already fragile and are often affected by declining world commodity prices and an overvalued real exchange rate in this case would have a negative effect on the financial health of producers in these sectors.

For sectors that produce homogenous products which are standard, market power is non-existent and this leads to a reduction of profit margins as a result of an overvalued real exchange rate (Abida, 2011). For industrial sectors, an overvalued exchange rate is deleterious due to forward and backward linkages that exist across sectors. In this regard, overvaluation effects on tradable sectors like agriculture will be spread to other sectors through the spillover mechanism. Service sectors (finance, insurance, real estate and communication) are also impacted by an overvalued exchange rate with services that are reliant on the tourism industry likely to suffer mostly. If an economy can market itself as a potential destination worth visiting like South Africa, then tourism may become a source of export of revenue. When the local currency is overvalued, tourism may be hard-hit as an overvalued exchange rate makes the country an undesirable destination and this later causes service sectors to lose out.

In general however, the goods markets are severely affected by an overvalued exchange rate. Both export and import competing sectors lose out financially in terms of profit. As a result, current and future investment is likely to be affected leading to a decline in growth of the sectors concerned. Real exchange rate overvaluation can impact both domestic and foreign investment in tradable sectors of the economy (Razin and Collins, 1997). Since investment decisions are formulated and based on price signals (of which the real exchange rate is one), a real exchange rate misalignment will facilitate a misallocation of resources.

If the exchange rate is misaligned (either undervalued or overvalued), agents in the economy (chartists and fundamentalists) will form expectations from price uncertainties and this consequently affects investment (Dubas, 2012). This slowdown in sectoral investment will necessitate a drop in future growth and production which later affects future employment too. The problem of unemployment on the other hand has secondary effects on the entire economy. The loss of jobs in key sectors will be translated into less money in the economy necessitating a fall in demand which is accompanied by a further decrease in production and further unemployment through multiplier effects.

Mbaye (2012) emphasises the capital accumulation hypothesis as a channel through which the exchange rate affects growth. The argument is that the real exchange rate affects sectoral growth through its effect on savings. This hypothesis claims that an undervalued real exchange rate facilitates growth in sectors through an increase in capital stock that emanates from an increased savings rate. This capital accumulation operates strongly in tradable sectors whose contribution towards the gross domestic product rises.

Levy-Yeyati and Sturzenegger (2003) argue that an undervalued real exchange rate can increase savings through a number of channels. In particular, an undervalued real exchange rate implies that firms are paying low wages in real terms and this lowers costs of production so that firms in sectors can invest more. The validity of this theoretical argument is however subject to critic on causal grounds. Bernanke (2005) for instance argues that causation runs from a high savings to an undervalued real exchange rate and not from exchange rate to savings. The gist of this argument is that a high savings rate depresses domestic demand resulting in a depreciation of the real exchange rate.

Another theoretical proposition that has been used to link exchange rate to growth is that of export-led growth theory. This hypothesis holds that expansion of exports is a key to growth and an undervalued real exchange rate encourages growth of exports in tradable sectors such as agriculture, mining and manufacturing. Tradable sectors are expected to grow on the back of an undervalued real exchange rate in this regard because they are not as constrained by domestic demand as other non-tradable sectors. Empirically, China’s growth could be illustrative. The country has long been accused of maintaining an undervalued real exchange rate and the rise in exports has to a larger extent spurred growth over the last two decades.

If a real exchange rate is undervalued, it means that exports are cheaper. The increase in demand for the country's exports in turn facilitates an increase in demand for labour required to produce for the export market taking into account that labour has a derived demand. An increase in employment then encourages growth in tradable sectors on the assumption of low labour to capital ratio. Drawing lessons from China, this hypothesis is tempting considering the concurrence of events i.e. the growth in GDP on the back of an undervalued real exchange rate, increased exports and a reallocation of labour from traditional sectors towards urban manufacturing sectors (which are tradable sectors).

Advocates of export-led growth argue that increased exports are an engine of growth (Giles and Williams, 2000). Hamel (1991) contends that increased exports imply a higher exposure to foreign competition and this increases pressure on the exporting sectors to operate efficiently and provide incentives for technological change. In this line of thinking, growth of exports is viewed as a driving force for sectoral productivity via externalities of exports on other tradable sectors.

From standard open economy macroeconomic theory, one can also argue that the real exchange rate has expenditure switching effects in the sense that if it is undervalued, consumer expenditure is going to be shifted towards domestic consumption (since goods produced in the foreign market will be relatively expensive) and this increase in domestic consumer demand is accompanied by a corresponding increase in production of goods in the economy. On the other side, an overvalued real exchange rate makes imports cheaper and thereby shifts expenditure from domestic consumption towards foreign consumption. The drop in domestic consumption will lead to a decrease in the production of domestic goods as a result also of the competition from the foreign market.

The theoretical reasoning borrowed in this study to establish how undervaluation links to growth is the one proposed by Rodrik (2008). The idea is that a real exchange rate misalignment in the form of undervaluation fosters growth by incentivising production of tradable goods which are generally characterised by market distortions and institutional weaknesses. Key to this argument is the fact that tradable sectors such as agriculture, manufacturing and mining suffer disproportionately from market distortions relative to non-tradable sectors such as construction. An undervalued real exchange rate therefore acts as a second best mechanism that gets rid of such market distortions and encourages growth of tradables. Real exchange rate misalignment in the form of overvaluation therefore acts as a tax and by increasing already existing market distortions, growth of tradable sectors will be compromised. At the outset of the model, an undervaluation of the exchange rate is expected to influence growth in tradable sectors by affecting its relative profitability.

3.3 Empirical Literature

Despite the arguments that sector-specific responses to real exchange rates have important implications for the response of the whole economy, there exist only a few studies that empirically examine the response of sectoral output or production to real exchange rate changes. The earliest related sectoral studies by Branson and Love (1987) and Revenga (1992). The former study examines the impact of real exchange rate movements on employment and output of the U. S. manufacturing industry for the period of 1963-1985. They construct a reduced model for employment and output from a simple supply and demand model which consists of 3 sectors: exportables, import-competing goods and the non-tradable goods sector. Based on 2-digit, 3-digit and 4-digit ISIC manufacturing industries, they conclude that exchange rate movements have had important effects on the U.S. manufacturing sector. The largest losses in employment and output due to the appreciation of the dollar are seen in the durable goods sector including primary metals, fabricated metal products, and non-electrical machinery. It also has an effect on stone, clay and glass products, transportation, instruments, textiles and apparel, chemicals, rubber and leather goods.

Similarly, Revenga (1992) estimates the effect of real exchange rate changes on U. S. manufacturing sector employment of 38 3-digit and 4-digit SIC manufacturing industries mostly focussing on the import competition of sectors. She provides empirical evidence that appreciation of the dollar between 1980 and 1985 reduce employment on average by 4.5 to 7.5 percentage points. She also states that the higher the import share of an industry, the more the dollar appreciation damages domestic labour market.

Kandil and Mirzaie (2002), decomposing the movement of the exchange rate into anticipated and unanticipated components, estimate output and price equations for nine U.S. sectors: Agriculture, Construction, Finance, Manufacturing, Mining, Retail Trade, Services, Transportation and Wholesale Trade. They argue that the expansionary and contractionary effects of the dollar appreciation on industrial real output growth offset each other since the changes in real exchange rate have not any statistically significant effect in any sector. However, unanticipated depreciation of the dollar negatively affects the real output growth in

Wholesale Trade, while unanticipated dollar appreciation decreases Finance real output growth significantly.

3.3.1 Cross-Country Panel Data Studies

Gala (2008) finds a positive correlation between real exchange rate undervaluation and growth for a panel of 58 developing countries for the period 1960–1999. Glüzmann et al. (2012) explore the effect of undervalued currency on different components of GDP such as consumption, investment, saving, exports, imports and employment in order to determine the channels of this effect. They show that, for developing countries, undervaluation does not seem to affect the tradable sector by promoting exports or creating a substitution from imports but instead leads to greater domestic savings and investment, as well as employment. Di Nino et al. (2011) extended the work of Rodrik (2008) by using a more recent Penn World Tables (PWT) dataset, by extending the time span which goes back to 1861 and by using alternative real exchange rate measures such as the WPI and CPI-based measures of PWT dataset. Their results corroborate those documented in Rodrik (2008).

Skott et al. (2012) modify the study of Rodrik (2008) by changing the definition of developing and developed country samples. They show that his finding is sensitive to the criterion used to divide the sample between developed and developing countries. Rodrik (2008) classifies developing (developed) countries as those with a real GDP per capita of less (more) than $6000. If the cut-off point is selected from anywhere between $9000 and $15.000, the estimated coefficient becomes highly significant for developed countries.

Recent years have seen a proliferation of studies seeking to address the effects of real exchange rate misalignment on economic growth. The results have however been mixed at best with the source of empirical contradiction ranging from the way studies have measured their misalignment variable, difference in sampling periods, difference in the units of analyses to the difference in estimation procedures, particularly in the handling of endogeneity and other related estimation problems.

Most of the studies, have been conducted at an aggregated level focussing on total GDP; an approach which we argue is exposed to aggregation bias given the heterogeneity of sectoral responses to movements in the real exchange rate. We argue that sectoral analyses would provide a valuable contribution to the existing knowledge since this approach not only minimise the risk of aggregation bias but also affords us an opportunity to appreciate how real exchange rate misalignment affects particular sectors. This approach can be viewed in another way as a complementary effort to aggregate growth studies in the sense of allowing one to trace the growth channels of an undervalued or overvalued real exchange rate.

Literature on real exchange rate misalignment has taken different dimensions. Some studies examine the total deviations of the real exchange rate from the equilibrium value while others have been interested in examining the nonlinearities in the relationship between real exchange rate misalignment and economic growth (Elbadawi et al., 2012, Sallenave, 2010, Toulaboe, 2006, Dubas, 2009). Most, if not all, of these studies measure misalignment as a deviation of the actual real exchange rate from an estimated equilibrium value and then assess how these deviations affect growth using GMM and fixed effects modelling techniques in a bid to address endogeneity and the mystery of unobserved country specific omitted factors. The main conclusion drawn from these studies is that real exchange rate misalignment is harmful to economic growth and that countries must resort to an exchange rate policy that aligns the real exchange rate to the equilibrium value.

This conclusion that real exchange rate misalignment has a detrimental effect on economic growth and that countries must maintain stable exchange rates is challenged by Berg and Miao (2010) and Rodrik (2008). Using similar approaches (cross country regressions and the GMM techniques) but with a slightly different approach to measuring real exchange rate misalignment, Rodrik (2008) challenged the idea that misaligned real exchange rates are not good for growth. For data observed from 1950 through 2007 on more than 100 countries, Rodrik (2008) shows that misalignment in the form of undervaluation can encourage long-run economic growth in developing countries and that the effect operates through the size of the tradable sector particularly the manufacturing sector. Quantitatively, a 10 percent rise in undervaluation is expected to boost growth by on average 0.2 percent in the subsequent 5 year period. These results are replicated by Berg and Miao (2010).

The explanation suggested by Rodrik (2008) underpinning his result is that tradable sectors in developing countries are exposed to market failures and institutional weaknesses that tax their production. An undervalued real exchange rate would then act as a second best mechanism that alleviates those distortions and subsidises their production. As in Rodrik (2008) and Berg and Miao (2010), Levy-Yeyati et al. (2013) provide evidence of a positive relationship between an undervalued real exchange rate and economic growth in a pool of countries. Their point of divergence with Rodrik (2008) however is the channel through which undervaluation encourages growth. As mentioned earlier, Rodrik (2008) mainly stressed the size of the tradable channel.

Tradable sectors such as manufacturing are expected to benefit from an undervalued real exchange rate taking into account the market and institutional failures that limit their expansion which an undervalued exchange rate alleviates and also the fact that tradable sectors are not constrained by domestic demand. The latter point implies that tradable sectors can produce and export on the world market and grow on those grounds. This can be viewed as a mercantilism type of growth. Contrary to this channel, evidence in Levy-Yeyati, Sturzenegger and Gluzmann (2013) instead suggests that undervaluation promotes growth though increasing savings and capital accumulation.

3.3.2 Studies on Nonlinearities

There is also another branch of literature which has simultaneously estimated the effects of an overvalued and an undervalued real exchange rate. This is known in the empirical literature as a test for nonlinearities. A recent study which uses this approach is that of Dubas (2012). The author invoked the panel dynamic ordinary least squares (DOLS) estimation technique to determine the equilibrium real exchange rate and measure the degree of exchange rate misalignment.

In a cross-country framework employing a standard growth regression similar to that used in Toulaboe (2006), the study confirms a detrimental effect of overvaluation on economic growth while the opposite effect is confirmed for undervaluation. These findings therefore offer support to those reported in Rodrik (2008) and Berg and Miao (2010). Interesting is that the study observes that developing countries are more sensitive to exchange rate misalignment relative to developed countries; an observation documented in Rodrik (2008).

3.3.3 Country-Specific Studies

While most of the empirical studies on real exchange rate misalignment have relied on cross-country panel data techniques with different sampling periods (Sallenave, 2010, Berg and Miao, 2010, Glüzmann et al., 2012), Yan and Yang (2012) invoked a single country approach in evaluating the effects of an undervalued real exchange rate on economic growth in the context of Taiwan. Despite the advantages of cross-country regressions (such as bringing more diversity into the sample and providing more degrees of freedom), single country studies are merited in explicitly addressing country specific factors combined with an ability to provide country specific policies.

Measuring misalignment as deviation of the prevailing real exchange rate from the equilibrium value, Yan and Yang (2012) use country-specific data and find a significant correlation between undervaluation and growth. This result is also in line with the result obtained in cross-country regressions and this is confirmatory. A similar country specific study by Zakaria (2010) in the context of Pakistan uses quarterly time series data spanning the periods 1983Q1 through 2005Q4 and reaches the same conclusion that undervaluation encourages economic growth.

3.3.4 Sectoral Studies

Sectoral studies on a single country basis have however not been kind to the prediction that undervaluation encourages growth. For instance, Masunda (2011) explores the nonlinear effects of real exchange rate misalignment on three sectors; agriculture, mining and manufacturing in Zimbabwe for the period spanning 1980 through 2003. Noteworthy is that these three sectors are largely tradable in a developing country like Zimbabwe hence Rodrik (2008) would predict them to grow on the back of an undervalued exchange rate. Contrarily, the results demonstrate a strong and negative correlation between undervaluation and sectoral growth.

One can chose to look at this empirical contradiction from two angles. The first angle could be that Masunda (2011) managed to solve aggregation bias through conducting a sectoral analysis and hence the result could show the true picture of how undervaluation relates to specific sectors. In spite of controlling for aggregation bias however, Masunda's analysis was exposed to one key shortfall that is worth mentioning. The author relied on the Feasible Generalised Least Squares Procedure (FGLS) which does not adequately address problems of endogeneity. Thus from the other angle, the negative correlation between undervaluation and sectoral growth could be taken to reflect pertinent endogeneity issues.

In other studies, undervaluation is found not to significantly bring growth at all. This result was demonstrated recently in Brixiová and Ncube (2014) in the context of Zimbabwe. Focussing on the three sectors namely agriculture, mining and manufacturing using a misalignment variable measured from the stock flow approach, the authors conclude that overvalued exchange rates have contributed to the economic collapse of sectoral growth in Zimbabwe but they do not find a robust positive link between undervaluation and sectoral growth.

With the exception of Masunda's (2011) analysis, a positive correlation between undervaluation appears to be acknowledged in many empirical studies. The point of multiplicity however lies in demonstrating the level of undervaluation which brings growth. This has given birth to yet another new branch of literature that seeks to address the asymmetries in the effects of undervaluation on growth. This literature has fortunately taken advantage of recent econometric advances particularly the emergence of Panel Smooth Transition Regressions (PSTR) that has allowed researchers to identify the threshold effects of undervaluation. Béreau et al. (2010) and Couharde and Sallenave (2013) find nonlinear effects of real exchange rate misalignment from applying Panel Smooth Transition Regressions.

In the literature, some of the studies have focussed on a single sector. Vaz and Baer (2014) for instance capitalises on a panel data set of 39 countries and the manufacturing sector at the 2-digit level between 1995 and 2008 to explore drivers of growth in the manufacturing sector. Exploring the within-sector–country variation to ascertain the empirical relationship between exchange rate over/undervaluation and growth of the manufacturing sectors growth, they find a positive correlation between currency undervaluation and sectoral growth with surprisingly import content of exports as the most significant driver of this key finding.

Berka et al. (2014) concentrate on how real exchange rates correlate with productivity at sector level for a set of Eurozone countries. Based on a sticky price dynamic general equilibrium model and a time series measure of real exchange rate, they demonstrate a significant link between real exchange rate and sectoral productivity. The concept of misalignment was however not rigorously explored.

3.3.5 South Africa Specific Studies

With respect to South Africa in particular, Elbadawi et al. (2012) using the Generalised Method of Moments (GMM) on 77 countries including South Africa for the period 1970—2004 conclude that overvaluation is detrimental to economic growth and the effect is more severe in countries with a fragile financial system. Recently a similar finding was confirmed in Iyke and Odhiambo (2015) using panel data techniques on 15 Sub Saharan countries including South Africa over a 40 year period. The authors relied on the within estimators and the generalised method of moments techniques and confirm a positive relationship between the two measures of real undervaluation and economic growth while the converse relationship is confirmed between real exchange rate overvaluation and economic growth.

Country specific studies for South Africa are very scant. Among them is a study by Sibanda et al. (2013) which applies the Johansen and Julius test for cointegration and the vector error correction model on data observed at quarterly intervals from 1990:01-2010:04 and reveals a negative effect of misalignment on economic growth. Zwedala (2013) on the other hand uses the behavioural equilibrium approach to measure real exchange rate misalignment and the vector error correction model to establish its growth effects. For the period 1985 up to 2011, the results show that real exchange rate misalignment stimulates economic growth if it comes in the form of undervaluation.

Bhorat et al. (2014) estimate sectoral employment effects of exchange rate fluctuations in South Africa using annual data observed from 1975 through 2009. They focus on non-agricultural sectors and methodologically rely on a regression model similar to the one employed by Chen and Dao (2011). Their findings indicate an inverse relationship between real exchange rate appreciation and employment in tradable sectors. Given that sector expansion can be viewed in terms of employment or output, their findings are very influential in the formulation of a priori expectations in our study since tradable sectors are included in the sample.

Özyurt (2013) conducted a similar analysis but focussing on the service sector in a panel setup consisting of 66 countries (including South Africa) for the period stretching from 1983 to 2007. The primary aim was to ascertain the impact of exchange rate misalignment on the services sector using different measures of exchange rate misalignment. The results confirm that currency undervaluation, per capita income and productivity have a significant influence on expansion of services. Mpofu (2013) in the context of South Africa employ an Autoregressive Distributed Lag (ARDL) bounds testing procedure to establish the empirical link between real exchange rate volatility and expansion of the manufacturing sector between 1995 and 2010. He finds that volatility of the real exchange rate has contractionary effects on the manufacturing sector. Although the study focusses primarily on volatility, a noteworthy result is that real exchange rate undervaluation encourages employment in the manufacturing sector.

Ngandu (2008) focusses on how the exchange rate relates to sectoral expansion in terms of employment in South Africa. Relying on a Computable General Equilibrium (CGE) model, the author observes an overall positive correlation between exchange rate appreciation and employment. The results also confirm that the effect of exchange rate appreciation is heterogeneous across sectors. In particular, exchange rate appreciation significantly encourages employment in the services sector while exchange rate appreciation pulls back employment in the manufacturing sector. The study was however limited in using a static modelling approach (the CGE) which does not accommodate dynamics of the exchange rate.

This positive correlation between exchange rate appreciation and performance of the service sector in terms of employment is also corroborated in Guo and N'Diaye (2009). From a sample consisting of 29 countries, they find a positive relationship between overvaluation of the exchange rate and the employment share of services. They argue that greater purchasing power of households in the domestic economy facilitates a rise in the demand for imported goods which consequently enhances the profitability of the non-tradable sector.

3.3.6 Industrial Growth Studies

Some studies have focussed on the effects of real exchange rate on industrial production. Enu et al. (2013) for instance sought to establish the empirical link between a set of macroeconomic indicators and industrial production in the context of Ghana. Using the ordinary least squares (OLS) estimator for data observed over a period of 21 years, the authors confirmed a negative and significant correlation between exchange rate appreciation and industrial production. The study had two main shortcomings. The first is that of a small sample size which made the analysis susceptible to micronumerosity (problems of small data observations). The second is that of using the OLS estimator which a priori categorises variables into exogenous and endogenous with the implication of endogeneity if the regressors are endogenous. This raises scepticism on the consistency of results given the endogeneity of the real exchange rate in any growth model.

Simon-Oke and Aribisala (2010) rather focussed on how deregulation of the exchange rate relates to industrial performance in the context of Nigeria. Using data observed from 1975 through 2005 and co-integration techniques, the results of the study indicate a cointegrating relationship between the exchange rate and exchange rate deregulation among other variables on industrial performance. An error correction model is then harnessed to explore short-run dynamics and exchange and interest rates turn out to be significant drivers of industrial growth in Nigeria. These findings reiterated the need for the Nigerian monetary authorities to embark on an appropriate exchange rate policy in order to boost industrial growth.

Al-Rashidi and Lahiri (2013) improve the knowledge curve by using a sector-specific measure of real exchange rate that accounts for heterogeneity of trade patterns across industries. In particular, the authors use an industry-specific trade weighted measure of real exchange rate as it is capable of capturing movements of industry output relative to the macro measure of real exchange rate. Allowing for asymmetries in the way the trade weighted measure of real exchange rate correlates with industrial output, they surprisingly find a positive and significant correlation between real exchange rate depreciation and industrial output. On the other hand, the effect of real exchange rate appreciation is found to be negative but not statistically significant.

3.4 Chapter Summary

This chapter has presented the theoretical concepts of the study particularly measuring real exchange rate misalignment. In this direction, section 3.1.2 briefly described the traditional and highly celebrated purchasing power parity, 3.1.3 then outlined the black market premium approach while 3.1.4 conceptualised the fairly recent model-based approaches of measuring real exchange rate misalignment. The chapter then proceeded to review theory on real exchange rate misalignment and economic growth in section 3.2 and empirical literature in section 3.3.

There are quite a number of empirical caveats to learn from the review of related literature before advancing to the empirical analysis. One obvious observation is that the literature is characterised by mixed findings. The dominant result in this bag of mixed results is that real exchange rate misalignment particularly overvaluation affects economic growth but the effects of undervaluation remains unclear. Some studies such as Rodrik (2008) confirm a positive effect of undervaluation, others such as Masunda (2011) confirm a negative effect while others find no effect of undervaluation at all on economic growth.

In light of this unsettled debate, this study contributes mainly by conducting a sectoral analysis in order to address aggregation bias that may have confounded the results obtained in earlier studies bearing in mind that most of them were performed at an aggregated level. Another gap that emerges in the literature is that of South Africa specific studies. There seems to have been limited effort that has thus far sought to establish the effects of real exchange rate misalignment on sectoral performance in South Africa. Where such literature exists, the focus has been on performance measured in terms of employment and not sectoral growth. The next chapter outlines the analytical framework of the study.

CHAPTER 4

ANALYTICAL FRAMEWORK

The previous chapter provided a conceptual framework of the study as well as a review of related theoretical and empirical literature. This chapter outlines the analytical framework adopting some of the concepts discussed in the previous chapter. The essence of this chapter is to provide an empirical guide as to how the entire analysis is performed in terms of the analytical techniques and the nature of data used. With this in mind, the chapter is organised into the following sections.

Section 4.1 a theoretical framework. Subsequent to the theoretical framework, section 4.2 will specify the baseline empirical models which address the specific objectives of the study specified in chapter one. Having specified the empirical models, section 4.3 will proceed to outline the estimation strategy of the specified models. Diagnostics testing will follow in section 4.4 while robustness checks and time series techniques will be outlined in section 4.5 and 4.6 respectively. Section 4.7 summarises the contents of the entire chapter.

4.1 Theoretical Framework

Economic growth theory was pioneered by Solow (1956) and Swan (1956) based mainly on the neoclassical theory. The neoclassical theory of growth maintained assumptions of a well-behaved neoclassical production function, production of a homogenous single good, labour augmenting technical progress, exogenous growth of labour force and full employment of resources. This theoretical model, famously known as the Solow and Swan predicts that the level of per capita gross domestic product (GDP) in the steady state will be determined by prevailing technology and exogenous technical progress, population growth and savings rate.

The assumption of exogenous technical progress in the Solow and Swan growth model implies that at equilibrium or in the steady state, growth will solely result from exogenous population growth and technical progress. The second most popular growth theory is the endogenous theory which assumes constant and increasing returns to capital. Development of these theoretical models is largely credited to Romer (1986) and Lucas (1988). Long-run growth emanates from exogenous technical progress and the theory predicts that capital will generate externalities that minimise operation of diminishing returns to scale.

Generally, the real exchange rate has not featured in traditional growth models and its importance came in the seminal work of Barro (1995). The majority of empirical studies on real exchange rate undervaluation and growth take advantage of endogenous growth theory as the model relates a country's level of per capita growth to a set of economic, political and social variables (Barro, 1995). Among the policy variables that affect growth are stabilisation policies, external conditions and structural and institutional policies. Stabilization policies encompass monetary and fiscal policies and these have an effect on an economy's short-run and long-run growth prospects (Birol, 2015). Lack of price stability and economic competitiveness are embraced in these two central policies and within growth theory and are captured by the inclusion of inflation figures (Barro, 1995). Among the stabilisation policies are issues of external competitiveness and external imbalances; these are proxied by the index of real exchange rate undervaluation.

For our analysis, we consider the conditional convergence growth theory which captures the exchange rate policy stance and sector-specific variables without loss of generality where a sector that starts off poor is predicted to grow faster and catch up with richer sectors. Relative to endogenous growth theories, the neoclassical conditional convergence theoretical framework allows us to unravel answers to a number of puzzling empirics such as the disparities in sectoral performance in terms of growth and the rate at which poor sectors can catch up with richer ones. In this context, there are a number of reasons why poor sectors may converge with richer sectors including the flow of capital from already rich sectors to poor sectors and the technological lagging of poor sectors. The conditional convergence theoretical model takes the following form.

$$\hat{y}_j = \beta(\ln y^*(\Theta_j) - \ln y_i) + \varepsilon_j$$

This theoretical model has also been used in related studies such as Vaz and Baer (2014) and Karadam (2014), where $\hat{y}_j = q_T$ denotes the growth rate in sector j, Θ_j is a vector of sector-specific factors that govern the long-run steady state, β is the rate of convergence and $\varepsilon_j$is a random error term. The convergence coefficient can also be represented by $\beta = {\ln(1 + T\hat{\beta})}/{T}$ where T is the time lag. The half-life in this case is obtained from $\tau = {-\ln(2)}/{\ln(1 + \hat{\beta})}$. What enters Θ_j are called growth fundamentals which are essentially a set of factors that tell us where each sector is heading in the long-run. While this set of fundamentals is large in principle, only key sector-specific factors, labour and capital plus the exchange rate undervaluation are considered as conditioning variables for the purpose of this discussion.

In this theoretical framework following Mbaye (2012) and Levy-Yeyati and Sturzenegger (2003), we expect exchange rate undervaluation to facilitate the catch-up effect through promotion of savings and capital accumulation. This is in line with the conditional neoclassical convergence theory which states that poor sectors or countries that start off poor can grow faster due to increasing returns to capital and catch up with richer sectors or countries. Within the auspices of this theoretical framework, the next chapter specifies the empirical models.

4.2 Specification of Empirical Models

The undervaluation measure is treated as an economy-wide variable. The study follows the approach used in Rodrik (2008) which derives undervaluation from the domestic price level of real exchange rate adjusted for the Balassa-Samuelson effect. Calculation of the undervaluation variable proceeds in three steps, with the first step defining the real exchange rate as follows:

$$\ln RER_t = \ln(XRAT_t / PPP_t) \quad (1)$$

where; *XRAT* and *PPP* denote the exchange rate and the purchasing power parity (PPP) respectively expressed as national currency units per United States (US) dollar. The PPP in this case refers to the number of units of the Rand required to purchase the exact amounts of goods and services that one US dollar would purchase in the USA. Controlling for the Balassa-Samuelson effect requires, in the second step estimation of an equation in which the real exchange rate in (1) is regressed against real gross domestic product per capita (GDP_CAP).

$$\ln RER_t = \alpha_0 + \alpha_1 GDP\_CAP_t + \varepsilon_t \quad (2)$$

where, α_0, α_1 and ε denote the intercept, slope coefficient and the independent and identically distributed random term with a zero mean and constant variance respectively. It is important to note at this point that productivity shocks can also impact the real exchange rate via other channels for instance investment demand. Viewed from this angle, an increase in productivity can bring about investment growth leading to a rise in the interest rate in order to attract the necessary capital to fund it. This will appreciate the real exchange rate. To accommodate such potential endogeneity that results from third variables that may affect the real exchange rate, equation 2 is estimated by the Stock and Watson dynamic ordinary least squares (DOLS) technique. The DOLS technique addresses endogeneity and serial correlation through leads and lags of first differenced regressors. Undervaluation is then defined as the deviation of the actual real exchange rate in equation (1) from the Balassa adjusted rate in equation (2) as follows:

$$\ln UNDERVAL_t = \ln RER_t - \ln \widehat{RER}_t \quad (3)$$

Where $\ln \widehat{RER}_t$ is the predicted value of the real exchange rate in equation (2). A value above unity indicates an undervalued currency which makes goods produced in South Africa relatively cheaper in terms of the dollar. On the other hand, a value less than unity will signify an overvaluation of the local currency in dollar terms. Following the work of Vaz and Baer (2014) and Karadam (2014), the measure of undervaluation generated from equation 3 is then used as a predictor variable in the sectoral conditional convergence equation in order to appreciate how it affects sectoral growth as a conditioning factor.

$$\ln Y_{it} = \lambda + \delta \cdot \ln Y_{it-5} + \omega \cdot \ln UNDERVAL_t + \varphi \cdot \ln \chi_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (4)$$

$$i = 1,2, \ldots ,6 \; t = 1,2,3 \ldots ,6$$

And $\chi = \begin{bmatrix} L_{it} \\ K_{it} \end{bmatrix}$ and $\varphi = \begin{bmatrix} \varphi_1 \\ \varphi_2 \end{bmatrix}$ where L =employment and K = capital stock

From equation 4, the dependent variable is sectoral growth which is a change in the average annual growth of a five year non-overlapping window. Differentiating equation 4 with respect to $\ln UNDERVAL_t$ yields the slope coefficient of interest, ω, which governs how undervaluation of the local currency interacts with sectoral growth. Two aspects that are important on ω are 1) its sign and 2) significance.

Most of the studies (Rodrik, 2008, Woodford, 2009, Berg and Miao, 2010) which place real exchange rate undervaluation on the right hand side of the growth equation find a positive sign implying a positive relationship between undervaluation and growth. The latter aspect requires hypothesis testing in order to establish whether or not ω is significantly different from zero.

Also appearing on the right hand side of the equation is, χ which is a 2×1 vector of explanatory variables which includes employment and capital stock in each sector, φ is a 2×1 vector of slope coefficients and $\ln Y_{it-5}$ represents initial income which is proxied, in this case, by the natural logarithm of output in each sector at the start of every 5 year non-overlapping period. Inclusion of the two mentioned explanatory variables is backed both by theory and the empirical application of the principle of parsimony.

The convergence term δ, being negative or positive would be taken to reflect convergence or divergence of sectoral growth respectively that is conditioned on employment in each sector, capital formation plus a measure of exchange rate undervaluation. Lastly, μ_i and $\eta_t$absorb sector and time fixed effects respectively while ε_{it} is the error term with usual properties $\varepsilon_{it} \sim iidND(0, \sigma^2)$. Sectoral growth enters the model as the dependent variable and is constructed as the first difference of real output in natural logarithm as follows:

$$\Delta \ln Y_t = \ln Y_t - \ln Y_{t-1}$$

Capital enters the regression model as a predictor variable and by construction, it is gross fixed capital formation. This can be measured either at the beginning of the year or at the end of the year but using investment data recorded at the end of the year is flawed in that part of the investment would have been used in the production process. Also, there is a possibility that firms in sectors may choose to sell part of their investment before end of the year. If firms sell part of their investment before the year ends, using figures recoded at the end of the year may not give an accurate picture of the actual investment that resulted in output growth in that year. Taking this into account, we use gross capital formation recorded at the beginning of the year.

A number of studies including Udah et al. (2015) and Masunda (2011) confirm the significant effect of capital on sectoral growth. Consistent with these studies, capital is included in equation 4, proxied by fixed capital formation in each sector with an expected positive sign. The theoretical argument behind this *a priori* expectation is that investment adds up to the available capital stock within the sector necessitating an increase in capital stock with a corresponding increase in growth.

Labour is captured by employment in each sector. Although the number of hours worked is, in most cases, conceptually a better proxy of the labour input, one can argue that employment is a relatively more reliable measure. The number of hours worked are considerably more erratic due to holidays and strikes which may concurrently occur in the same reference week. For this reason coupled with the fact that the number of hours worked is only available for a few sectors, we decided to use employment as a proxy of the labour input since it is consistent across all sectors by measurement. From standard growth theory, a positive sign is *a priori* expected.

Exchange rate undervaluation is derived from equation 3 and enters equation 4 on the right hand side as an explanatory variable to appreciate how it affects sectoral growth. Although the literature is inconclusive regarding how undervaluation relates to sectoral growth, it is fair to expect a positive sign *a priori*. Table 1.2 describes the variables and the *a priori* expectation on each explanatory variable.

Table 1.2: Variable Description and *Apriori* Expectations

Variable	Description	Expected Sign
Sectoral growth	Growth in sectoral output	
Labour	Employment in sectors	+
Capital	Gross capital formation	+
Undervaluation	Balassa-adjusted undervaluation baseline measure	+

The empirical analysis is based on 2 digit level International Standard Industrial Classification (ISIC) data and 6 sectors, agriculture, finance, manufacturing, tourism, mining and personal services with data observed from 1985 through 2014. The starting period allows us to focus on the period where South Africa was operating a flexible exchange rate policy post the breakdown of the Bretton Woods system of pegged rates. The Bretton Woods system collapsed in 1973 but South Africa continued to operate a pegged rate regime until the early 80s.

Selection of the ending period on the other hand is based on data availability. Following recent literature, data is converted into 5 year averages in order to remove cyclical effects. This transformation yields 6 non-overlapping 5 year windows (1985 – 1989, 1990 – 1994, 1995 – 1999, 2000 – 2004, 2005 – 2009 and 2010 – 2014). This implies 6 observations per sector. The final panel property of the data is therefore $T = 6, N = 6$. The data sources are World Development Indicators (WDI), South Africa Statistics (Stats SA) and PENN World Tables (PWT) version 9.0. These are reliable data sources both at local and international level.

4.3 Estimation Strategy

Equation 4 can conventionally be estimated using either the pooled least squares, fixed effects or the random effects. The pooled least squares technique is simply the ordinary least squares and does not consider heterogeneity among individual sectors over time. Thus it does not consider the panel nature of data. In addition to this, parameter estimates obtained from the pooled least squares may be heavily biased due to the heterogeneity between explanatory variables and the disturbance term (Baltagi, 2008). It is because of this inadequacy that the fixed effects and the random effects models come in handy.

The fixed effects modelling strategy assumes a correlation between the error term and the entity specific effect (sector-specific effect in this particular case) ($corr(v_i; X_{it}) \neq 0$) and essentially attempts to control for all those sector-specific effects. The disturbance term, which is essentially the source of difference between the random effects and the fixed effects, can be specified as;

$$\mu_{it} = v_i + \varepsilon_{it}$$

where v represents individual unobserved heterogeneity and ε_{it} are idiosyncratic errors. This is termed the one way error component model because it accounts for unobserved individual time invariant effects (v_i) and not time fixed dummies. It becomes a two way error component model when time fixed effects are also accounted for as follows:

$$\mu_{it} = v_i + u_t + \varepsilon_{it}$$

where u_t represents time fixed effects and other symbols are as defined before. The individual effects are included to absorb unobserved individual heterogeneity. In this case, we can think of this unobserved heterogeneity as emanating from factors that are specific to each sector, like soil quality which may affect agriculture and not manufacturing. On the other hand, time fixed effects (time dummies) may be included to wipe off technical changes so that the effect of our explanatory variables becomes comparable over time.

The choice between estimating a one-way or two-way error component model is customarily based on the F-tests for joint significance of each category of dummies (individual effects and time effects). The fixed effects model, which has mostly been used in the literature in preference to the random effects, can be estimated using either the least squares dummy variable approach (LSDV) or the within estimator (WE). The similarity between these two estimation strategies is that they both yield identical slope coefficients for non-dummy regressors.

The random effects model on the other hand assumes that the heterogeneity across sectional members exists in the error term and also that the error term is not correlated with explanatory variables. The appropriate model between the random effects is conventionally determined by the Hausman specific test. The null hypothesis of the Hausman specification test is synonymous with zero covariance between the individual unobserved heterogeneity and the explanatory variables, which is essentially the random effects assumption; hence rejection of this null has often been taken to reflect acceptance of the fixed effects model.

The more commonly used estimation strategy between these two has been the fixed effects estimation technique partly because of its ability to account for unobserved individual heterogeneity. In spite of this ability however, our final model poses more than one estimation challenges and most of them are beyond the control of the fixed effects technique. In particular, our final model specification raises concerns of endogeneity emanating from three central sources. The first source is the Nickell-Hurwicz bias due to the initial income variable $\ln Y_{it-5}$ in equation 4. This bias confounds every dynamic model estimated by one way fixed effects techniques in the presence of finite T.

Nickell (1981) shows that the fixed effects estimator will carry a bias of $O(1/T)$ in a dynamic model setup and that this bias can be severe in small T. For panels with T around 30, the bias could be as high as 20 per cent of the true value (Judson and Owen, 1999). The limit of $\hat{\rho} - \rho$ as $N \rightarrow \infty$ will approximately be ${-(1+\rho)}\big/{(T-1)}$ (Nickell, 1981). In our case for ρ and $T = 6$, the bias will be -0.30 which is more than ${1}\big/{2}$ of the true value. The same problem is present even in the one-way random effects (Baum et al., 2012). The u_i error component will enter every y_{it}value by assumption so that the lagged term of the dependent variable will be dependent on the composite error process.

The second source of endogeneity emanates from the reverse causation running from sectoral growth back to the real exchange rate via the Balassa-Samuelson effect. The Balassa-Samuelson effect predicts that an increase in productivity in the tradable sectors exerts a rise in wages leading to an appreciation of the local currency. Viewed this way, growth in tradable sectors can also have a feedback effect on the undervaluation measure and the fixed effects strategy is not immune to such reverse causation problems.

The third source of endogeneity may be third variables that jointly affect undervaluation and sectoral growth. The fixed effects strategy assumes a correlation between the unobserved individual heterogeneity and the regressors but essentially maintains the assumption of orthogonality between the regressors and the error term. In reality however, the error term may be plugged by time variant variables that may affect both the regressors and the dependent variable. An example in this case would be inflows of foreign direct investment (FDI). A rise in FDI inflows may stimulate sectoral growth and simultaneously appreciate the local currency through increasing domestic consumption.

Although the fixed and random effects modelling strategies acknowledge the panel nature of the dataset relative to the pooled least squares, they unfortunately do not survive endogeneity of this sort and as such their slope coefficients may be biased. To address these kinds of endogeneity, a standard solution in the literature is the use of instrumental variable regressions. The 2 stage (2SLS) and 3 stage least squares (3SLS) are examples which immediately spring into one's mind. The mechanics behind these approaches are embedded in finding an instrument which is a variable correlated with the endogenous regressor (the real exchange rate in this particular case) but uncorrelated with the error term. The endogenous regressor will then be regressed against this instrument using the OLS technique and the fitted values obtained from this regression will be used as the explanatory variable in the final regression.

In our case, the challenge of using these approaches lies in finding a variable that is correlated with the real exchange rate without having an independent effect on sectoral growth. Most of the variables that affect growth are the same variables that affect the real exchange rate and therefore finding a suitable instrument is an empirical challenge.

The solution suggested in empirical panel data studies is to take advantage of lagged values of the variables as instruments in the Generalised Methods of Moments (GMM) framework proposed by Arellano and Bond (1991). This is the approach used in this study and it is preferred because of its ability to pin down endogeneity issues using internal instruments. A close alternative estimator that addresses endogeneity problems of this sort is the Anderson and Hsiao (AH) technique. Arellano and Bond (1991) argue however that the AH estimator although consistent fails to absorb all the potential conditions of orthogonality. A further advantage of the GMM estimator is embedded in its consistency even in the presence of non-stationary panels (Binder et al., 2005) and adequately deals with issues of measurement error and other noise in data. The latter ability of the GMM technique is important given the potential noise in sectoral data. Technically in terms of their setting, the GMM estimator is based on differencing regressions and/ or instruments in order to account for unobserved effects and using lagged dependent and independent variables as instruments. It is based on a dynamic model of the following sort where we treat all regressors as endogenous.

$$\ln Y_{it} = \lambda + \alpha \cdot \ln Y_{it-1} + \delta \cdot \ln Y_{it-5} + \omega \cdot \ln UNDERVAL_t + \varphi \cdot \ln \chi_{it} + \varepsilon_{it} \quad (5)$$

By incorporating the lagged term of the dependent variable, equation 5 can be viewed as a partial adjustment model where $\alpha - 1$ is the partial adjustment mechanism. The use of sector level data however brings to the forefront the issue of heterogeneity of sectors which has to be properly addressed even in a dynamic setting (Cameron and Trivedi, 2005). In the context of GMM estimators, this unobserved heterogeneity is removed by first differencing equation 5 as follows;

$$\ln Y_{it} - \ln Y_{it-1} = \lambda + \alpha\,(\ln Y_{it-1} - \ln Y_{it-2}) + \delta\,(\ln Y_{it-5} - \ln Y_{it-10}) + \omega\,(\ln UNDERVAL_t - \ln UNDERVAL_{t-1}) + \varphi\,(\ln \chi_{it} - \ln \chi_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) \quad (6)$$

By letting Δ denote the first difference operator, equation 6 can be re-expressed as;

$$\Delta \ln Y_{it} = \lambda + \alpha \cdot \Delta \ln Y_{it-1} + \delta \cdot \Delta \ln Y_{it-5} + \omega \cdot \Delta \ln UNDERVAL_t + \varphi \cdot \Delta \ln \chi_{it} + \Delta\varepsilon_{it} \quad (7)$$

First differencing our specification this way wipes away sector-specific effects but requires instrumentation to control for 1) endogeneity of the regressors and 2) the correlation between the new error term $(\varepsilon_{it} - \varepsilon_{it-1})$ and the lagged depended variable$(\ln Y_{it-1} - \ln Y_{it-2})$.

In a panel data setup, initial values of regressors as well as the lagged response variable are capitalised as instruments and this constitutes the difference GMM estimator. Blundell and Bond (1998) show however that the difference GMM estimator is exposed to weak instruments in cases where the covariates are persistent over a period of time. Presence of weak instruments further distorts both the small sample and asymptotic performance of the difference estimator. A solution to this problem of weak instruments is proposed by Blundell and Bond (1998) and Arellano and Bover (1995) and it requires using a system GMM which combines the first differenced equations with the equation in which the level regressors are instrumented by their first differenced terms. Blundell and Bond (1998) through Monte Carlo simulation conclude that the system GMM estimator is relatively more efficient as compared to the first difference estimator. For this reason, this study uses the Blundell and Bond system GMM as the baseline estimator.

The Blundell and Bond system GMM can be estimated using one-step or two-step. The one-step system GMM estimator employs a variance covariance matrix while on the other hand the two-step system GMM estimator capitalizes on the residual values generated from the first estimation step for variance covariance matrix, $\boldsymbol{\widehat{\Omega}_i = \hat{\varepsilon}_i \hat{\varepsilon}_i',}$ which is utilized in the second estimation stage. Both the one-step and two step estimators can be performed with heteroscedasticity corrected standard errors.

The two-step system GMM estimator is considered to be relatively more efficient as compared to the one-step estimator with a heteroscedastic error-structure. Nonetheless when the size of n (cross sectional members, sectors in this particular case) is small relative to the number of instruments used, the standard errors from the two-step system GMM estimator will be downward biased (Blundell and Bond, 1998). The bias on the standard errors will later compromise and distort statistical inferences on the parameters of our explanatory variables. In such a case where n is smaller than the number of instruments, the one-step system GMM estimator will be relatively more reliable (Blundell and Bond, 1998). In the present case, we have only 6 sectors and therefore the issue just mentioned above is very relevant if more lags are used as instruments. Mindful of this fact, the one-step system GMM estimator is employed.

It is now well known among economists that correlation does not equal causation. The issue of sorting out the direction of causality is an empirical challenge which confronts every researcher dealing with non-experimental data. In this respect, the use of single equation modelling approaches as specified above implies an assumption of unidirectional causality running from the explanatory variables to the response variable. This assumption is not free from empirical criticism. As mentioned by the external reviewer in earlier drafts of the paper for instance, one can argue that the exchange rate could rather be a reflection of the country's poor growth performance as capital outflows that are looking for new growth potential elsewhere, depress the value of the currency. Hence if we observe undervaluation and then growth rises we reach one conclusion but if growth rises and then we observe a change in the level of undervaluation, we reach another. This issue therefore reduces to the problem of finding a better way of sorting out the direction of causality.

Although there is no perfect way of doing so, a customary practice that has been used in empirical literature is one which is based on the timing of events; that is artificially creating a situation where we could observe the values of our explanatory variables and then observe the response of the dependent variable. This practice essentially requires one to use initial rather than contemporaneous values of the explanatory variables and this is the approach adopted in this study. By using lagged instead of contemporaneous values of the explanatory variables, we are able to partly address causal issues by establishing how initial values of the real exchange rate affect sectoral growth in subsequent periods. In this regard, regressors in this system are lagged once so that we are able to identify how the change in any of the regressors in the current 5 year window relates to growth in the following 5 years.

This approach may however not be the best way of dealing with causality issues taking into account that in reality people often change their behaviour not in response to a change in the present conditions but rather in response to a change in their expectations of the future. For instance, residents of a country that expect poor economic performance in the future may move their capital (hot money) elsewhere now and therefore depreciate the exchange rate. In this case it will be the change in the expectations of future growth prospects that would have affected the level of undervaluation not to suggest that the current level of undervaluation will affect future growth. Regardless of this flaw, the hope is that using the system GMM will complement the weaknesses of using initial values of regressors as a way of tackling causal issues.

Data is transformed into 5 year averages which diminishes concerns of non-stationarity in the GMM framework since in this case each sector will enter with only 6 data observations. Phillips and Moon (1999) further indicate that non-stationarity issues are much less of a problem in a panel data setup due to the averaging in panel estimation strategies that reduces prospective noise. The same approach is adopted in a recent paper by Bittencourt et al. (2014). In addition to the averaging of data, the variables are expressed in logarithms which neutralises the variance thereby reducing the possibility of estimating spurious regressions.

4.4 Diagnostic Tests

It is critical to test the validity of certain assumptions that underpin the success of the system GMM estimation technique. These tests must essentially address the validity and relevance of the instruments used in the system. The first diagnostic test is the Sargan test for over-identifying restrictions. This diagnostic test allows us to determine exogeneity or validity of the instruments. The second diagnostic test is the Arellano and Bond test for AR (2) autocorrelation. Presence of $AR(1)$ autocorrelation is generally taken to reflect relevance of the instruments. On the other hand, presence of will $AR(2)$ autocorrelation will imply inappropriateness of the lags of endogenous variables as instruments of their current values.

Time effects are customarily included in panel data regressions to absorb technical changes and the effects of common shocks on growth over time. Their inclusion is determined by their joint significance in the model. If the F-test produces a significant result, then time dummies will have to be included. In this study however, the time dummies enter the system insignificantly hence they are not included to save degrees of freedom and to avoid unnecessary model overfitting. Sectoral fixed effects on the other hand do not have to be tested in the system GMM as they are already dealt with by first differencing in equation 7.

An important issue that that needs to be tested is endogeneity of the regressors; particularly real exchange rate undervaluation. Endogeneity is a violation of the assumption of zero covariance between the regressors and the error term. If the regressors surrender their exogeneity due to either feedback effect or third variables sitting in the error term, their slope coefficients will be inconsistent carrying a small sample bias that does not vanish asymptotically. In this study, endogeneity is mainly suspected theoretically on exchange rate undervaluation taking into account the Balassa-Samuelson effect which predicts a feedback effect of the productivity rise in the tradable sector to the exchange rate.

In spite of these theoretical arguments leading to suspicion of endogeneity of undervaluation, the use of the system GMM technique to control this estimation problem must well be balanced with the loss of efficiency if the regressors happens to be exogenous (Wooldridge, 2003). It is therefore in this regard important to perform a formal test of endogeneity in order to determine whether or not the GMM technique is in the first place required instead of the pooled least squares. To achieve this in this study, the Durbin – Wu – Hausman (DWH) test of regressor endogeneity is employed. The null hypothesis of the DWH test holds that the variables are exogenous.

In addition to endogeneity, an equally important aspect in our case relates to contemporaneous correlation. Contemporaneous correlation exists when the idiosyncratic disturbance terms are correlated across individuals. If this is the case, hypothesis testing will be grossly compromised leading to distortion of statistical inference (Everaert and De Groote, 2016). It is important in this study to test for contemporaneous correlation because the GMM estimation strategy assumes autocorrelation within the individual units' error terms but not across them (Baum et al., 2012). We suspect in this case cross sectional dependency that may emanate from spillover effects among the sectors. For instance the agriculture sector relies on services of the financial sector while the manufacturing sector on the other hand absorbs most of inputs from the agriculture sector.

To test for cross sectional dependency in this study, we use a method developed recently by Pesaran (2015) and Chudik and Pesaran (2015). The null hypothesis of this test holds that the residuals are weakly cross sectional dependent and it is rejected if the null hypothesis is less than 10 percent. More technically, if the residual series for member i in the panel at time t is denoted by $\mu_{i,t}$, the hypothesis can then be expressed as;

$$H_0 : E(\mu_i, \mu_{j,t}) = 0, \forall\, t \text{ and } i \neq j$$

The t-statistic for this test is derived from;

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right)$$

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = {\sum_{t=1}^{T}\hat{\mu}_{i,t}\hat{\mu}_{jt}}\Big/{\left(\sum_{t=1}^{T}\hat{\mu}_{it}^2\right)^{(1/2)}\left(\sum_{t=1}^{T}\hat{\mu}_{jt}^2\right)^{(1/2)}}$$

where $\hat{\rho}_{ij}$ signifies the correlation coefficient for a balanced panel. This expression is valid for a balanced panel but it changes in the case of an unbalanced panel. This study is based on a balanced panel therefore for brevity; the derivation of the t-statistic of an unbalanced panel is not expressed.

The pairwise correlation matrix is then used to measure the degree of linear correlation among the variables. Multicollinearity ranges between 0 and 1 with the former value describing an orthogonal relationship while the latter describes perfect collinearity. It is important to measure the degree of linear association among independent variables because if they are perfectly collinear, it will be practically impossible to isolate their partial effects on the dependent variable. In such a case, one can only obtain the joint effect of the two variables on the dependent variable.

Last but not least, most of the studies have found existence of nonlinearities in the way real exchange rate undervaluation correlates with growth. This implies that real exchange rate undervaluation may have two and opposite effects depending on whether the degree is below or above the threshold. If the relationship is nonlinear and one estimates only the linear effect, the penalty could be specification bias owing to model under-fitting.

To test if indeed the relationship is nonlinear or not, we include in a stepwise fashion, the quadratic term of real exchange rate undervaluation and assess the sign and significance of both the linear and the quadratic term. Presence of a significant positive and negative sign on the linear and quadratic term respectively will be taken as evidence of nonlinearities and hence existence of a turning point in the effects of undervaluation on sectoral growth. This exercise must not be confused with the first assumption of the classical linear regression assumptions as our model will only be nonlinear in variables but still linear in parameters.

4.5 Robustness Checks

Robustness checks are meant to ensure that our results are not sensitive to changes in our methodological approach. If one invokes more than one analytical techniques and still reach a similar conclusion, then the results of the baseline methodology will be robust and reliable for policy formulation purposes.

As our first robustness check, we consider alternative estimation strategies. The Blundell and Bond system (GMM) is quite robust to endogeneity problems but maintains the assumption of slope homogeneity. In a practical sense there is reason for one to doubt the validity of this assumption in the short-run given the heterogeneity of production technologies used across sectors. Therefore to accommodate potential coefficient heterogeneity, we use the common correlated effects (CCE) estimator proposed by Pesaran (2006). The CCE estimator is robust to coefficient heterogeneity, existence of common correlated effects among sectors and most importantly possible unit roots in factors. The specification of the model takes the following form.

$$y_{it} = \vartheta_i + \varphi_i x_{i,t} + \varepsilon_{i,t} \qquad (8)$$

$x = \begin{bmatrix} L \\ K \\ U \end{bmatrix}$ & $\varphi = \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \end{bmatrix}$ L = employment, K =capital stock and U =Undervaluation

where

$$\varepsilon_{i,t} = \gamma_i' f_t + \epsilon_{i,t}$$

From these two specifications, f_t captures the unobserved common factor while γ_i represents the heterogeneous factor loading. Importantly, the heterogeneous slope coefficients are distributed randomly around a common mean so that:

$$\varphi_i = \varphi + v_i, \quad v_i \sim IID(0, \Omega_v)$$

As defined before, y_{it} represents growth in sector i at time period t and X is a vector that contains the already mentioned variables, undervaluation, labour and capital. Because the CCE is non-dynamic, we drop the initial income variable to avoid the Nickell Bias. Also since the

CCE requires the time dimension to be sufficiently large, annual observations are used instead of 5 years averages for this robustness exercise.

In addition to being robust to heterogeneous slope coefficients, another attractive feature of the CCE estimator is the ability to simultaneously show cross sectionally averaged estimates as group specific estimates. The latter means that one can also ascertain how undervaluation correlates with growth in each sector (although this washes away the essence of data being panel in the first place). Secondly, we estimate the same model this time using the Augmented Mean Group (AMG). The AMG estimator introduced in Eberhardt and Teal (2010) accounts for cross-sectional dependence by controlling as an explanatory variable a common dynamic process.

That having been said, an important argument raised by Woodford (2009) is that 5 year averaging removes cyclical effects but may obscure the long-run effect of regressors. Taking this criticism into account as a robustness check, I change the data frequency from 5 year averages to annual observations. Using annual rather than 5 year averages implies a panel property of $T = 29$ and $N = 6$ which is a thin panel or panel time series. Relative to the system GMM estimation where data was observed at low frequency (5 year averages), the fact that our time dimension is now relatively higher raises the natural question of panel non-stationarity.

The concept of stationarity is a customary one which naturally arises when data is observed over a period of time. If a variable is generated by a non-stationary process, it means its variance is non-mean reverting over time and in such cases the standard regressions may be spurious. To test for panel non-stationarity, I employ both the first and second generation panel unit root tests. The first generation tests in particular are due to Levin and Lin (1993), Harris and Tzavalis (1999) , Im et al. (2003), Maddala and Wu (1999), Choi (2001) and Hadri (2000). Second generation tests include Bai and Ng (2004), Pesaran (2007) and Breitung and Das (2005).

The reason why I employ several tests is that none of them is not without its own limitations. Employing a number of them therefore allows us to compare their results for robustness purposes and this is a customary practice in the literature. The first test that we invoke is the Levin and Lin (1993) panel unit root test and it is derived from the following expression,

$$\Delta y_{i,t} = \alpha_i + \rho\, y_{i,t-1} + \sum_{z=1}^{p_i} \beta_{i,z} \Delta y_{i,t-z} + \varepsilon_{i,t} \qquad (9)$$

The null hypothesis is of a non-stationary process. Technically speaking, this panel unit root test orthogonalises the disturbance terms basing on the correction from the ratio of long-run to short-run variance of the variable in question. The test is however limited in maintaining a homogeneity assumption and allowing only heterogeneity in the intercept of the Augmented Dickey Fuller (ADF) regression.

The second test that is performed is the Im, Pesaran and Shin (IPS) panel unit root test which requires us to separately specify an ADF test for each member in the panel without a time trend but with individual effect. The IPS test presumes that a variable y_{it} has a generating process of a finite AR (P_{i+1}) as follows;

$$y_{it} = \mu_i \phi_i(1) + \sum_{j=1}^{p_i+1} \mu_{ij} y_{i,t-j} + \varepsilon_{it} \qquad (10)$$

$$i = 1,2,3, \dots, N \; t = 1,2,3, \dots, T$$

where;

$$\mu_i \phi_i(1) = 1 - \sum_{j=1}^{p_i+1} \phi_{ij}$$

This is equivalent to the ADF (P_i) regression specification of the following form;

$$\Delta y_{i,t} = \gamma_i + \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \qquad (11)$$

where;

$$\gamma_i = \mu_i \phi_i(1), \;\; \beta_i = -\phi_i(1), \qquad \rho_{ij} = -\sum_{h=j+1}^{p_{i+1}} \phi_{ih}$$

The Im et al. (2003) test is based on the following null hypothesis;

$$H_0; \beta_i = 0, for\ all\ i$$

This null hypothesis is tested against the following alternative hypothesis;

$$H_a; \beta_i < 0\ for\ i = 1, \dots, N, \beta_i = 0\ for\ i = N_{1+1}, N_{1+2}, \dots, N$$

In testing $\beta_i = 0$ the $t - bar$ statistic is computed as the average of individual test statistics as follows:

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}(P_i, \rho_i)$$

Im et al. (2003) then suggested standardisation of this t-bar arguing that when $N \; and \; T \to \infty$, the standardised statistics converges to a standard normal distribution. The proposed standardised $t - bar$ is formed from the following specification;

$$W_{\overline{t(P,\rho)}} = \frac{\sqrt{N}(\bar{t}_{NT} - \frac{1}{N}\sum_{i=1}^{N} E\{t_{iT}(P_i, 0)|\beta_i = 0\})}{\sqrt{\frac{1\sum_{i=1}^{N} var\{t_{iT}(P_i, 0)|\beta_i = 0\}}{N}}}$$

The distribution of $W_{\overline{t(P,\rho)}}$ converges to the standard normal sequentially as $T \to \infty$ first and then as $N \to \infty$. Unlike the Levin, Lin and Chu (1993) test, the IPS panel unit root tests allows heterogeneity of both the intercept and slopes of the ADF regression. Breitung and Das (2005) proposed the following t-statistic for unit root testing,

$$\Delta y_{it} = s_t \left[\Delta y_{it} - \frac{1}{T-t}(\Delta y_{it+1} + \cdots + \Delta y_{iT})\right]$$

This test has however low asymptotic power properties as pointed out by Moon et al. (2006), Hadri (2000) developed a different approach to testing for unit root in panel data. This test has a null of stationary panels (absence of a unit root) and accommodates individual specific variances as well as potential correlation. The Hadri test can be specified as,

$$y_{it} = \delta_{mi} d_{mt} + \varepsilon_{it} \qquad (12)$$

The Hadri test technically extends the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test of a panel with time effects, individual effects and deterministic trends. This test however suffers a strong tendency of rejecting stationarity in the presence of serial autocorrelation. Maddala and Wu (1999) proposed a panel unit root test of a Fischer type that relies on probability values derived from individual root tests. This stationarity test takes the following ADF form,

$$-2\sum_{i=1}^{N}(\ln p_i) \sim \chi^2(2N)$$

This study uses the second generation test by Pesaran (2007) approach as the baseline test given its ability to accommodate potential cross sectional dependency. The test proposed by Pesaran (2007) is cross sectionally augmented and takes the following form,

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i^*(N,T)$$

This test is robust to cross sectional dependency as well as individual specific autocorrelation. As will be shown in the next chapter, the results from panel unit root tests suggests non-stationarity of variables in level form but stationarity after first difference. Given that variables are integrated of order one (I (1)), the next step was to test for a cointegration among the variables.

There are a number of cointegration tests in the literature and because none of them is free from critique, I employ several of them for robustness purposes. Maddala and Wu (1999) propose a Fischer-Johansen test for cointegration of the following form.

$$\Delta Y_{it} = \Pi_i y_{it-1} + \sum_{k=1}^{n_i} T_k \Delta Y_{it-k} + u_{it} \qquad (13)$$

To accommodate heterogeneity, Pedroni (2001) developed a residual based test for cointegration. This method requires estimating the following long run relationship:

$$y_{it} = \alpha_i + \delta_i t + \beta_{it} x_{1,it} + \cdots + \beta_{Mi} x_{M,it} + \varepsilon_{it} \quad (14)$$

$$for\ i = 1, \ldots, N : t = 1, \ldots, T : m = 1, \ldots, M$$

where N is the number of panel individual members, T is the time period and M is the number of exogenous variables. The disturbance term which follows a $AR\ (1)$ process is structured as follows:

$$\varepsilon_{it} = \rho_i \varepsilon_{it-1} + \sum_{j=1}^{p_i} \psi_{ij} \Delta \varepsilon_{it-1} + v_{it} \qquad (15)$$

The Pedroni cointegration test has seven different statistics four of which are based on the within dimension and three are based on between dimension. All the test statistics are constructed to test the null of no cointegration.

A similar residual based test for cointegration was suggested by Kao (1999). The Kao test for cointegration is based on a null hypothesis that the disturbance term is non-stationary and homoscedastic. The test is derived from the following expression:

$$\hat{\varepsilon}_{it} = \rho\, \hat{\varepsilon}_{it-1} + \sum_{j=1}^{p} v_j \Delta\hat{\varepsilon}_{it-j} + v_{it} \qquad (16)$$

Westerlund (2007) and Persyn and Westerlund (2008) developed the following error-correction test for cointegration which is applicable even in the presence of a mixture of integration (Van Bon, 2014).

$$y_{it} = \delta_i' d_t + \alpha_i y_{it-1} + \gamma_i' x_{it-1} + \sum_{j=1}^{p_i} \alpha_{ij} \Delta y_{it-j} + \sum_{j=0}^{p_i} \theta_{ij} \Delta x_{it-j} + e_{it} \quad (17)$$

Because in most cases cointegration is confirmed as will be shown in the following chapter, we proceed to estimate the long-run relationship. Several estimators can be performed in cases of a cointegrating relationship. The commonly used estimators are panel ordinary least squares (OLS), Johansen maximum likelihood, the dynamic ordinary least squares (DOLS), fully modified ordinary least squares (FMOLS) and the Pooled Mean Group (PMG).

Kao and Chiang (1999) show that the OLS estimation technique is normally distributed but asymptotically biased. As a result, they suggested a bias correction within the OLS framework but the correction did not perform well in small sample sizes. To compare small sample properties, Chiang and Kao (2002) perform Monte Carlo simulations for the DOLS, FMOLS and OLS estimators.

The Monte Carlo results show that the DOLS outperforms both the FMOLS and the OLS for cointegrating regressions in small samples. Baltagi and Kao (2000) further indicate that the DOLS could be more promising relative to the OLS in the event of a cointegrating relationship. Technically, the DOLS includes leads and lags of differenced explanatory variables and addresses endogeneity, regressor simultaneity and serial autocorrelation through the generalized least squares procedure.

Given the advantages of the DOLS relative to the FMOLS and OLS, the DOLS is used as a baseline estimator of this cointegrating relationship. For comparison purposes however as is customary in the literature, the FMOLS and the PMG estimators will be considered. The Johansen approach is not used because it acutely suffers small sample problems (Masunda, 2012, Mazorodze, 2014). The DOLS approach is derived from the following specification.

$$\ln y_{it} = \beta_0 + \sum_{i=1}^{n} \beta_i \ln F_{i,t} + \sum_{i=1}^{n} \sum_{j=-k_1}^{k_3} \gamma_{i,j} \ln \Delta F_{i,t-j} + \varepsilon_t \quad (18)$$

$$for\ t = 1985, 1986, \dots, 2014$$

where $\ln y_{it}$ is as sectoral GDP, γ is a vector of coefficients of leads and lags and F is a vector of our explanatory variables. Importantly, the coefficient of a lead or lag of the first differenced regressors and the estimated coefficient of the DOLS is given by:

$$\hat{\beta}_{DOLS} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \mathrm{z_{it}}\ \mathrm{z'_{it}}\right)^{-1} \left(\sum_{t=1}^{T} \mathrm{z_{it}}\ \hat{\mathrm{y}}_{\mathrm{it}}^{+}\right)$$

where $\mathrm{z_{it}} = [x_{it} - \bar{x}_i, \Delta x_{i,t-q} \dots \Delta x_{i,t+q}]$ is $2(q+1) \times 1$ vector of explanatory variables. The SIC will be used to select the optimal lead and lag. The FMOLS estimator adjusted for panel heterogeneity and serial correlation is derived from the following specification.

$$\hat{\beta}_{NT}^{*} - \beta = \left(\sum_{i=1}^{N} \hat{L}_{22i}^{-2} \sum_{t=1}^{T} (x_{it} - \bar{x}_i)^2\right)^{-1} \sum_{i=1}^{N} \hat{L}_{11i}^{-1}\ \hat{L}_{22i}^{-1} \left(\sum_{t=1}^{T} (x_{it} - \bar{x}_i)\ \mu_{it}^{*} - T\hat{\gamma}_i\right)$$

From this specification, $\hat{L}_i$ represents a lower triangular decomposition of Ω_I. The long-run standard errors can be represented by,

$$\hat{L}_{11i} = \left(\Omega_{11i} - \Omega_{21i}^{2} \Big/ \Omega_{22i}\right)^{\frac{1}{2}} \text{ and } L_{22i} = \Omega_{22i}^{1/2}$$

The FMOLS estimator in this respect, as demonstrated by Pedroni (2001), with individual specific mean can be expressed as,

$$\mu_{it}^{*} = \mu_t - \hat{L}_{21i} \Big/ \hat{L}_{22i}\, \Delta x_{it}, \hat{\gamma}_i \equiv \hat{\Gamma}_{21i} + \Omega_{21i}^{0} - \hat{L}_{21i} \Big/ \hat{L}_{22i}\, (\hat{\Gamma}_{22i} + \Omega_{220i}^{0})$$

The DOLS and FMOLS in a panel framework can be estimated using either the pooled, weighted or grouped method. Of these three, I use in both cases the grouped method since it is the most efficient. In any case, it is important to note that changing the estimation approach between the pooled, weighted and grouped only had slight effects of changing the size of the undervaluation coefficient otherwise the sign remained unaffected.

Furthermore, I rush to add that there is also a possibility of slope heterogeneity in our model given the differences of technologies used in the production process in each sector. The sample consists of sectors that lie at different stages of growth and development using different technologies. To accommodate this possibility of slope heterogeneity, I use the solution suggested by Pesaran et al. (1999) which is either the Mean Group (MG) or the Pooled Mean Group (PMG). The appropriate technique between the two is chosen based on the Hausman test as suggested by Pesaran et al. (1999).

In this study, the PMG is the preferred technique over the MG. The PMG is an intermediate estimator that allows the intercept, short run coefficients and error variances to differ across the groups but constraints the long run coefficients to be equal across groups as would the fixed effects. The PMG builds from an autoregressive distributed lag framework ARDL $(1,1,1,1)$ based on the SIC of the following form:

$$\ln y_{it} = \sum_{j=1}^{p} \lambda_{ij} \ln y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} \ln \chi_{i,t-j} + \sum_{j=0}^{q} \alpha'_{ij} \ln UNDERVAL_{i,t-j} + \mu_i + \epsilon_{it} \quad (19)$$

The lagged term $\ln y_{i,t-j}$ captures how past values of sectoral GDP feed into current output realisations. In the case of a cointegrating relation, equation 19 can then be parameterised into an error correction model as follows:

$$\Delta \ln y_{it} = \phi_i \left(\ln y_{i,t-1} - \sum_{j=0}^{q} \delta'_{ij} \ln \chi_{i,t-j} - \sum_{j=0}^{q} \alpha'_{ij} \ln UNDERVAL_{i,t-j} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta \ln y_{i,t-1}$$
$$+ \sum_{j=1}^{q-1} \omega^*_{ij} \Delta \ln \chi_{i,t-1} + \sum_{j=1}^{q-1} \delta'^*_{ij} \Delta \ln UNDERVAL_{i,t-j} + \mu_i + \epsilon_{it} \quad (20)$$

Where $\phi_i = -(1 - \sum_{j=1}^{p} \lambda_{ij}), \theta'_j = \sum_{j=0}^{q} \delta'_{ij} / (1 - \sum_k \lambda_{ik}), \lambda^*_{ij} = -\sum_{m=j+1}^{p} \lambda_{im}$

$$j = 1,2, \dots, p-1, and\ \delta'^*_{ij} = - \sum_{m=j+1}^{q} \delta_{im}\ j = 1,2, \dots, q-1$$

From equation 20, all variables are as defined before. Noteworthy is that ϕ is the error correction term which measures the speed of adjustment should there be any disequilibrium. It should carry a negative sign showing reversion back to the equilibrating state and ranges between 0 and 1 though it may exceed 1 but less than 2 in special cases. Δ is the first difference operator and it signifies the short run period while long-run information of real exchange rate undervaluation is contained in α'_{ij}.

So far, the DOLS, FMOLS, CCE, and PMG specified above are an effort to establish whether or not the relationship between exchange rate undervaluation and sectoral growth is influenced by the estimation technique used. It is also important for us however to probe whether or not the relationship is sensitive to the measure of undervaluation used. In this direction, I consider two alternative measures of undervaluation, the first being the Balassa-unadjusted and the second being the model-based measure.

Woodford (2009) raises concerns of a bias that arises from using the Balassa-adjusted measure of undervaluation. To assess the importance of this bias in changing the correlation between undervaluation and sectoral growth, auxiliary regressions are estimated with an unadjusted measure of undervaluation. This implies using the undervaluation measure that does not regress the real exchange rate on South Africa's income per capita.

As a last robustness check, it is important to note that both the Balassa adjusted and unadjusted measure of undervaluation are based on the domestic price level. In this regard, another alternative measure of undervaluation is considered which is based on attainment of internal and external balance. Calculation of real exchange rate undervaluation and overvaluation using this approach requires determination of the equilibrium real exchange rate; one which ensures internal and external balance.

In this regard, we follow a model of a small open economy developed by Edwards (1988). Empirically, this model has been applied in Toulaboe (2006), Masunda (2012) and Mazorodze (2014) in the form of the permanent equilibrium exchange rate model (PEER) rather than the behavioural equilibrium exchange rate (BEER) and the natural equilibrium exchange rate (NATREX). The model-based measure is merited in treating the real exchange rate as a dynamic variable that responds to macroeconomic fundamentals as opposed to the PPP approach which relies on a unrealistic assumption of treating the real exchange rate as an immutable time invariant number. The reduced form of the model takes the following form:

$$\ln e_t = \beta_0 + \sum_{n=1}^{N} \beta_n \ln F_{nt} + \varepsilon_t \qquad (21)$$

$$F = \begin{bmatrix} F_1 \\ . \\ . \\ . \\ F_n \end{bmatrix} \qquad \& \qquad \beta = \begin{bmatrix} \beta_1 \\ . \\ . \\ . \\ \beta_n \end{bmatrix}$$

where: $\ln e_t^*$ is the natural logarithm of the real exchange rate and $\ln F_{nt}$ is a vector of real exchange rate fundamentals. These fundamentals include government consumption, technological progress, trade openness and capital inflows $(C_{NG}, C_{TG}, \tau, \varphi, \lambda)$ as derived earlier in the theoretical framework. The Stock and Watson (1993), Dynamic Ordinary Least Squares (DOLS) is used to estimate this reduced form equation in a bid to address regressor endogeneity, simultaneity and potential serial correlation.

Under the DOLS technique, the optimal lag will be that with a lowest Schwarz Information Criteria (SIC) value. The SIC, which is one of the criteria used for assessing the validity of restrictions on the parameters in non-nested models, imposes a harsher penalty than does the alternative Akaike Information Criteria (AIC) as pointed out by Gujarati (2014) and this is the reason why the SIC is our preferred criteria. The SIC which is also known as the Bayesian Information Criteria (BIC) is asymptotically derived from the following specification,

$$-2 \cdot \ln p(x|k) \approx SIC = -2 \cdot \ln L + k \ln(n)$$

where, x = observed data, n = number of observations, k = parameters to be estimated, $p(x|k)$ = probability of observed data values given the parameters to be estimated and L = value of the likelihood function. The SIC specification assumes independent and identically distributed residuals and that the marginal condition of the derivative of the log-likelihood function with respect to the true variance is statistically zero.

From the SIC, the best model is one which uses lags that give the lowest SIC. The optimal lead on the other hand is selected on the basis of ingenuity and the ingenuity is based on observing the behavior of the mini-square error criteria (MSE). In this regard, a lead that increases the MSE worsens the fit of the model and is therefore dropped from the specification to avoid unnecessary model overfitting while a lead which lowers the MSE improves the model and is therefore retained.

The equilibrium real exchange rate for each time period will be obtained by multiplying the elasticities by the values of the fundamental variables. In this regard following Baffes et al. (1997), real exchange rate misalignment will be defined as:

$$Misal = \frac{e_t - e_t^*}{e_t^*}$$

so that;

$$\ln UNDERVAL = \frac{e_t - e_t^*}{e_t^*} < 0$$

where e_t is the actual real effective and e_t^* is the equilibrium real exchange rate. The generated undervaluation and overvaluation measures will then be separately inserted in the tradable sectoral growth model as explanatory variables. There is need at this point for describing and justifying the variables used in this equilibrium exchange rate determination model. Starting with the dependent variable in the theoretical model, the actual real exchange rate ($\ln e_t$) is defined as the relative price of tradable to non-tradable goods as follows:

$$e = \frac{P_T}{P_N}$$

Due to data unavailability on prices of traded (P_T) and non-traded goods (P_T), a theoretical concept of the real exchange rate has to be operationalised empirically as:

$$e = \sum_{i=1}^{n} (E_z \cdot WPI_{TD})^{w_i} / CPI_z$$

This is the real effective exchange rate defined as domestic price index in South Africa in relation to the price index of its main trading partners multiplied by the nominal exchange rate of the South African economy. From the formula, $WPI_{TD}$is the wholesale price index for the country's trading partners while $w_i$is the weight of the trading partner.

Government consumption, expressed as a percentage of GDP is used to capture the stance of the fiscal policy. Due to unavailability of data on government consumption on tradable (C_{NG}) and non-tradable goods (C_{TG}), total government consumption is used instead. A rise in government consumption of non-tradable goods causes the real exchange rate to appreciate while the real exchange rate depreciates if too much government consumption is concentrated on tradable activities. Either sign is therefore expected.

In line with the theoretical model of the equilibrium real exchange rate we also empirically control for technological progress (г). The Balassa-Samuelson theory postulates that productivity growth in tradable sectors versus the non-tradable sectors due to technological advancement leads to real exchange rate appreciation by stimulating demand in the non-tradable sectors. The challenge of the researcher lies in finding an appropriate proxy variable for technological advancement.

The earliest studies such as Ghura and Grennes (1993) captured the Balassa-Samuelson effect by a simple time trend. Others such as Razin and Collins (1997) proxied the Balassa-Samuelson effect by growth of GDP per worker. Recent studies have mostly use GDP per capita growth rate. None of these proxies is not without its own limitations but Toulaboe (2006) asserts that rapid growth in GDP per capita is very much associated with technological advancement. In line with this argument, this study uses GDP growth rate as a proxy for technological progress. A positive sign is expected.

From the equilibrium model, the trade policy variable variable (λ) is empirically calculated as the ratio of sum of imports plus exports to GDP. This measures the degree to which a country's real exchange rate is affected by the external environment. It is expected that trade openness exerts a downward pressure on the relative price of tradable to non-tradable goods, thereby leading to a depreciation in the real exchange rate.

Terms of trade dynamics (φ), another fundamental is defined as the foreign price of exports divided by the foreign price of imports. Effects of the terms of trade on real exchange rate are ambiguous. An improvement in terms of trade has both income and substitution effects in the sense that in one hand it leads to an increase in real wages allowing an intersectoral shift of mobile factors of production to the tradable sectors. This, in the context of the Dutch disease theory, will cause an appreciation of the real exchange rate. On the other hand, the substitution effect is explained as, an improvement in terms of trade lowers the cost of imported inputs in the production of non-traded goods causing real exchange rate depreciation. Either sign is therefore expected.

Lastly, capital flow is defined as the ratio of net foreign asserts to the GDP. Net foreign asserts capture the effect of a net capital inflow. Bhattacharya et al. (1997) argue that when net capital inflows exceed debt service obligations, the real exchange rate may appreciate while Baffes et al. (1997) justify the negative sign of the variable on its associated increases in domestic absorption particularly in the non-tradable sector.

4.6 Time Series Techniques

Estimation of sectoral panel data techniques is accompanied by time series approaches in a bid to track the effect of over/under-valuation on individual sectors. Importantly, the use of time series techniques warrants the use of annual observations otherwise using 5 year averages as in panel techniques would expose the analysis to micronumerosity (problems that arise from few data observations).

Before specifying the empirical models in a time series framework, the use of a relatively higher frequency (annual as compared to 5 year averages) brings to the forefront the obvious need for stationarity tests (stationarity tests are equivalent to testing for unit roots). If variables are non-stationary, the regression estimates may be spurious unless a cointegration exists among them. Testing for unit roots to distinguish between difference and trend stationary data is a customary practice in applied research. In testing for unit roots in time series, one issue of concern in our case is the potential existence of structural breaks in data. In particular, the data set is plagued by the Asia contagion effect in 1998, the debt standstill in 1985 and the Great Recession 2008-2009. Conventional tests for unit roots are the Dickey-Fuller (ADF), Elliot, Rothenberg, and Stock (ERS), Phillips-Perron (PP), Ng and Perron (NP), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests.

However, as argued by Perron (1994), structural breaks and unit roots closely relate and as such, conventional stationarity tests may be susceptible to a bias toward a false null hypothesis when in actual fact the series is trend stationary with a structural break. Taking this background into account, we use the modified augmented Dickey-Fuller test (MDF) which allows for levels as well as trends that statistically differ across a single break-date.

The modified DF test for unit root in the presence of a structural break defines three types of break variables. Letting $(\cdot)$ denote an indicator function which takes the value of 1 whenever the argument $(\cdot)$ holds and 0 if otherwise, the first variable called an intercept break variable can be expressed in terms of a specified break-date T_b.

$$DU_t(T_b) = 1(t \geq T_b)$$

This variable takes the value 1 after the break and 0 before the break date. The second is called the trend break variable and can be expressed as,

$$DT_t(T_b) = 1(t \geq T_b) \cdot (t - T_b + 1)$$

The variable takes the value 0 for all periods before the break date and is also a break date that is rebased trend for the entire subsequent dates. The third and final variable is termed one-time break dummy variable and takes the following form,

$$D_t(T_b) = 1(t = T_b)$$

This variable only takes the value 1 on the break date otherwise the variable takes the value of 0. In line with Perron (1994), we consider, in our case, one time break which takes the value of 1 on the break date. For data that does not exhibit a trend process, a one-time change in level model (O) is considered while three models are considered for trending data. The four models for trending data in particular are 1) model (A) which is a change in level, 2) model (B) which is a change in the level and trend and 3) model (C) which is simply a change in trend.

These models (one with non-trending data and the other with trending data) are further characterised by two versions that differ in the manner in which they accommodate the break dynamics. The first version is the innovation outlier (IO) which assumes a break that gradually takes place with the innovations or shocks moving on the same dynamic path with the break. The second version is the additive outlier (AO) which assumes a non-stationary process possibly with a structural break against a trend-stationary with break-alternative. For the innovation outlier model, the following null is considered.

$$y_t = y_{t-1} + \beta + \psi(L)(\theta D_t(T_b) + \gamma DU_t(T_b) + \epsilon_t)$$

where ϵ_t is an independent and identically distributed ($i.i.d$) shocks and $\psi(L)$ signifies a lag polynomial that represents dynamics of a stationary and invertible autoregressive moving average (ARMA) process. Here, it is worth noting that the break variables are entered in the model with same dynamic paths as those of the innovations. The alternative hypothesis maintains the assumption of trend-stationarity both in the intercept and trend and can be expressed as follows,

$$y_t = \mu + \beta t + \psi(L)(\theta DU_t(T_b) + \gamma DT_t(T_b) + \epsilon_t)$$

The proposition that break variables follow the dynamic path of the shocks still holds. The Dickey-Fuller test can then be performed to evaluate these hypotheses with k lagged differences of the univariate time series in order to absorb serial correlation. With respect to the additive outlier, the null hypothesis takes the following form,

$$y_t = y_{t-1} + \beta + \theta D_t(T_b) + \gamma DU_t(T_b) + \psi(L)\epsilon_t)$$

where ϵ_t and $\psi(L)$ are as defined before and β is a drift term. The full effect of the break variables in this case occurs immediately. The alternative hypothesis is for trend-stationarity with a potential breaks in both the trend and the intercept. This takes the following form,

$$y_t = \mu + \beta t + \theta DU_t(T_b) + \gamma DT_t(T_b) + \psi(L)\epsilon_t)$$

In the AO model, testing for stationarity proceeds in two steps. The first step uses the intercept, trend and the breaking variables in order to de-trend the time series using the ordinary least squares technique and the second step entails using the de-trended series to test for non-stationarity using a modified DF regression. The theoretical foundations of the test statistics require one to specify the optimal number of lags that eliminate serial correlation in the univariate time series. To achieve this, we use the AIC to select the optimal lag for each respective test that we perform.

The next important aspect deals with selection of the break date. Perron (1994) considered specifying an *a priori* fixed structural break date. However, selecting the break-date this way is arbitrary and may consequently compromise the entire set of inferences if an inappropriate date is selected. A solution to this problem suggested by Vogelsang and Perron (1998) is to endogenise the structural break date from the data. This is the approach used in this study.

Next we consider the concept of cointegration. Economists generally use the concept short-run and long-run in analysing economic relationships. Because these two concepts exist in principle, econometricians rely on the statistical definition of cointegration to describe the later. By definition, cointegration exists if a linear combination of non-stationary variables follows a stationary process. If this is the case, applied econometricians often conclude the existence of a long-run relationship among the variables.

By definition in statistical sense, cointegration can only be tested if variables are non-stationary and integrated of the same order. If this condition holds, (if variables are all I (1) for instance), the Engel Granger two-step approach and the Johansen tests can be applied with the choice between these two tests dependents on the objectives of the study apart from weighing the limitations of each of them. If for instance the objective is simply to detect existence of a long-run relationship, the former will suffice otherwise if the objective is to detect the number of cointegrating vectors, then the latter will be more appropriate.

The challenge faced by most economists empirically, including the present study, however is that variables may be integrated of different order that is some may be stationary in levels while others may be stationary after first differencing. Conventionally, this would make it impossible to proceed with cointegration testing since by definition, cointegration requires a linear combination of non-stationary variables to be stationary.

Although cointegration cannot exist in such cases, Pesaran et al. (2001) propose an alternative approach which can, at least help one to detect the presence of a long-run relationship among variables in levels if variables exhibit a mixture of integration. This approach is known as the bounds testing procedure and it is a test for a long-run relationship not cointegration. Given that the variables in this study were found to be integrated of different order, as will be shown in the following section, the bounds testing procedure was employed.

The autoregressive distributed lag (ARDL) bounds testing procedure has several advantages over other conventional methods. Relative to other approaches, the ARDL bounds testing procedure does not require the precondition that all variables must be non-stationary and integrated of the same order. This makes it applicable irrespective of the underlying order of integration.

Secondly, the ARDL bounds testing procedure is super-consistent in small sample sizes as compared to other methods like the Johansen which are appropriate in large samples. Thirdly, the bounds testing approach is capable of providing unbiased parameter estimates of the long-run relationship among variables as well as valid test-statistics even in the presence of endogenous regressors (Harris and Sollis, 2003). The bounds testing procedure starts with estimation of a conditional Autoregressive Distributed Lag (ARDL) model of the following form.

$$\Delta \ln Y_t = \delta_0 + \sum_{j=1}^{n} \varphi_j \Delta \ln Y_{t-j} + \sum_{j=1}^{n} \omega_j \Delta \ln UNDERVAL_{t-j} + \sum_{j=1}^{n} \gamma_j \Delta \ln \chi_{t-j} + \xi_1 \ln Y_{t-1} + \xi_2 \ln UNDERVAL_{t-1} + \xi_3 \ln \chi_{t-1} + \varepsilon_t \qquad (22)$$

$$for\ t = 1985, 1986, 1987, \dots, 2014$$

All variables are as defined before. Equation 22 is first estimated by the ordinary least squares technique. From this unrestricted ARDL model, presence of a long-run relationship can be tested by restricting the slope coefficients of variables in lagged levels. This requires specifying the following null and alternative hypothesis:

$$H_0\colon\ \xi_1 = \xi_2 = \xi_3 = 0$$

against:

$$H_a\colon\ \xi_1 \neq \xi_2 \neq \xi_3 \neq 0$$

The computed F-statistic is then compared with the critical values tabulated by Pesaran et al. (2001). An F-statistic less than the lower bound would imply that variables are jointly integrated of order zero (I(0)) and hence no long-run relationship exists by definition. On the other hand, an F-statistic above the upper bound would imply that variables are jointly integrated of order one (1(1)) and hence a long-run relationship exists among them. The decision would be inconclusive if the F-statistic lies in between the lower and the upper bound.

The value of the lower and the upper bound would require knowledge of k and the assumption of the long-run relationship. The conditional ARDL model in equation 22 is represented by $k+1$ where k is the number of regressors and 1 is the lagged dependent variable. Therefore in our case, we have 3 regressors (ln UNDERVAL, ln labour and ln capital) plus the lagged dependent variable which gives the k value of 3. With respect to assumption of the long-run relationship, Pesaran et al. (2001) suggest 5 cases. The first case assumes no intercept and no trend, the second assumes a restricted intercept and no trend, the third assumes unrestricted and no trend, the fourth assumes unrestricted intercept and restricted trend while the fifth assumes unrestricted intercept and unrestricted trend. The widely used assumption in empirical literature is case 3 and this is the assumption followed in this paper. If a long-run relationship is found to exists, then equation 22 can be reparametrised into the following error correction representation.

$$\Delta \ln\ Y_t = \delta_0 + \sum_{j=1}^{n} \varphi_j \Delta \ln Y_{t-j} + \sum_{j=1}^{n} \omega_j \Delta\ \ln UNDERVAL_{t-j} + \sum_{j=1}^{n} \gamma_j \Delta\ \ln \chi_{t-j} + \xi_1 \ln Y_{t-1} + \xi_2 \ln UNDERVAL_{t-1} + \xi_3 \ln \chi_{t-1} - \Phi \cdot ECT_{t-1} + \varepsilon_t \qquad (23)$$

$$for\ t = 1985, 1986, 1987, \dots, 2014$$

From this specification, Φ represents the error correction term (ECT) which captures the speed of adjustment if the model encounters some disequilibria. It must carry a significant negative sign showing reversion of the model back to the state of rest in case of an unexpected shock. In terms of the magnitude, the ECT ranges must lie between 0 and 1. If for instance, Φ turns out to be significantly 1, this would mean 100 percent of the disequilibrium will be corrected in the current period.

Several diagnostic tests are performed post-estimation of the ARDL model. The first test is that of model specification and here we consider the Ramsey Regression Specification Error Test (RESET). Generally, model misspecification is a result of omission of relevant variables, wrong functional form of the model, measurement error or simultaneity. Any of these can result in model misspecification and the implication is that the OLS parameters will be inconsistent with a bias in small samples that does not disappear asymptotically (even in large samples).

The main intuition behind the Ramsey RESET is testing to observe if a nonlinear combination of regressors has predictor power on the response variable. If it does, then the model will be misspecified. The null hypothesis postulates that the model is well specified and it is rejected if it is corresponded by a probability value that is less than the 10 per cent maximum significance level.

We also probe for parameter stability. This test is relevant in models that rely on data plagued by structural breaks. The challenge of estimating a model with unstable parameters is that it cannot be generalised over a long period of time and as such, the results cannot be used to make long term forecasting. The CUSUM test has normally been used to detect parameter instability. The parameters are considered to be unstable if the CUSUM line exceeds the 5 percent critical bounds computed by the test otherwise the parameters of the model will be stable. If parameter instability is detected, the solution will be to perform further tests to detect presence of a structural break so that a dummy variable can be included to accommodate such a break.

It is also important to test for heteroscedasticity which is a violation of the homoscedasticity assumption. If the residuals are heteroscedastic, it means that their variance is no longer constant across observations. The OLS estimates in this case will remain unbiased, consistent but less efficient which may grossly compromise statistical inference. The Breusch Pagan test is used to detect presence of heteroscedasticity. An advantage of this approach over alternative approaches is that it is able to detect heteroscedasticity of any form. The null of heteroscedasticity is rejected if the test is corresponded by a low probability value typically less than the 10 per cent significance level otherwise the null hypothesis will be accepted. If heteroscedasticity is prevalent in the model, the solution will be to re-estimate the model using robust standard errors.

Autocorrelation, which is prevalent in time series data, occurs when the residuals from independent time periods are correlated ($corr(\mu_i; \mu_j) \neq 0 \; for \; i \neq j$). If this is the case, the OLS estimates will remain unbiased, consistent but inefficient in the class of best linear unbiased estimators. This will lead to high standard errors and low test statistics which ultimately makes one accept every null hypothesis.

The Breusch Godfrey serial lagrangian Multiplier (LM) is used to detect presence of serial correlation among residuals; autocorrelation will be present if the test is accompanied by a probability value that is less than 10 per cent. An advantage of the Breusch Godfrey test over the conventional Durbin Watson (DW) approach lies in its ability to test higher order autocorrelation relative to the DW test which only detects first order autocorrelation.

4.7 Chapter Summary

This chapter has presented the research techniques employed in underpinning the relationship between real exchange rate undervaluation on growth of tradable sectors in South Africa. The key contents of this chapter are measurement of exchange rate undervaluation, specification of empirical models, both panel data and time series models, justification of variables and diagnostic tests.

As a baseline methodology, the study mainly uses a dynamic panel data approach estimated by the system GMM technique within the conditional convergence framework. Time series techniques particularly the bounds testing procedure and time trend analysis are then used to trace how real exchange rate undervaluation relates on individual sectors. The data are analysed using Econometric-views 9 and STATA 13 statistical packages. The next chapter presents and discusses the empirical findings.

CHAPTER 5

RESULTS AND DISCUSSION

The previous chapter outlined the analytical framework of the study. In line with the analytical considerations, this chapter presents, interprets and discusses the empirical findings of the study. The chapter is arranged in 4 main sections. The entry section 5.1 describes and summarises the data property. Section 5.2 then presents the econometric evidence while sections 5.3 and 5.4 will present results from alternative strategies, particularly panel time series and time series techniques. The last section 5.5 summarises the chapter contents.

5.1 A First Look at the Data

This section presents the descriptive statistics of the data.

Table 2.1: Summary Statistics (1985 – 2014)

	Mean	**Standard Deviation**	**Minimum**	**Maximum**	**Obs.**
Sectoral growth	0.027	0.022	-0.020	0.078	30
Initial income	5.622	0.327	4.901	6.159	30
ln capital	5.736	0.337	5.256	6.325	30
ln labour	5.189	0.262	5.630	6.558	30
ln UNDERVAL	0.007	0.038	-0.049	0.423	30
	Skewness	**Kurtosis**	**Jarque-Bera**	**Probability**	**Obs.**
Sectoral growth	0.130	2.467	0.439	0.802	30
Initial income	-0.667	2.929	2.234	0.327	30
ln capital	-0.631	2.476	2.339	0.310	30
ln labour	0.325	1.749	2.485	0.288	30
ln UNDERVAL	-0.455	1.430	4.117	0.127	30

The average annual growth of a 5 year period for a typical sector between 1985 and 2014 was 2.7 percent. The minimum and maximum growth rates were -2 and 7.8 percent respectively. The minimum growth was recorded between 2005 and 2009 in the mining sector and this could reflect the effects of the 2008/9 global recession. The 7.8 percent maximum growth on the other hand was posted by the financial sector between 2000 and 2004.

Each variable brings 30 observations into the sample emanating from 6 non-overlapping 5 year averages. From all the variables, the most volatile series expressed in terms of the standard deviation is suprisingly capital stock followed by initial income. Labour and sectoral growth are positively skewed while the remaining variables are negatively skewed. All the variables have a kurtosis value that is less than 3 (negative excess kurtosis). The implication is that all variables are platykurtic and therefore posses thin tails. The probability values of the Jarque Bera tests are greater than 10 percent implying a normal distribution of all variables.

Figure 5.2 is a histogram of sectoral growth distribution between 1985 and 2014. An important result coming from the distribution is that annual growth rates have been centered statistically and normally around 2 percent. This is quite encouraging as it indicates that sectors have generally been growing positively over the years despite sporadic economic downturns.

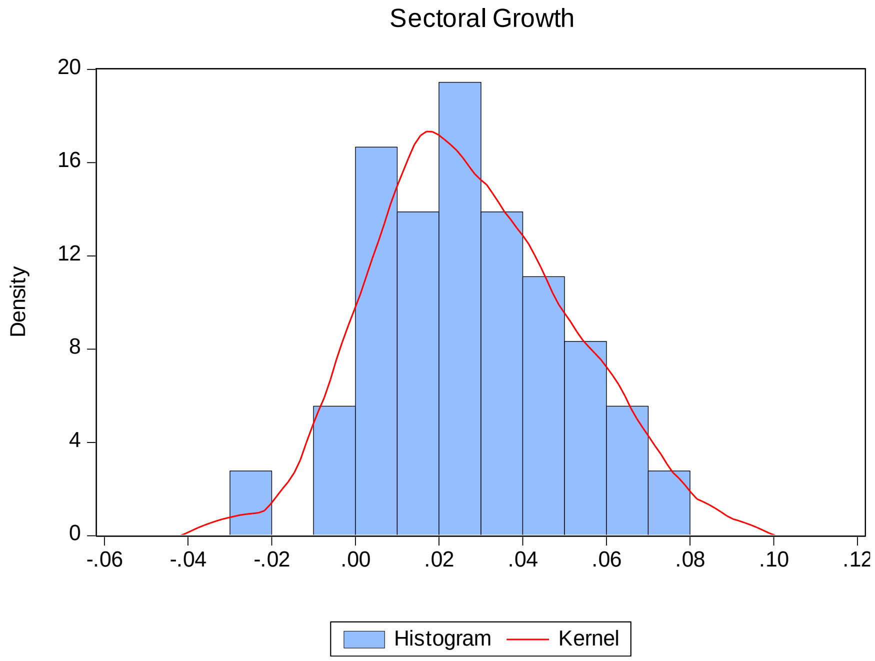


Figure 5.2: Annual Sectoral Growth Distribution (1985 – 2014)

Source: Computed Based on Data

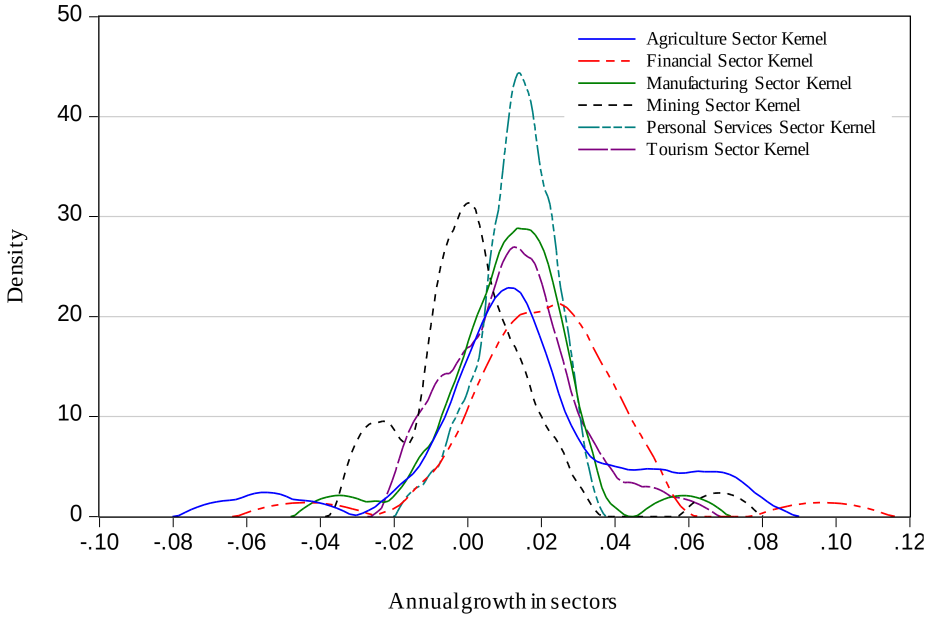


Figure 6.1: Kernel Density Growth Distribution

Source: Computed Based on Data

The kernel density also suggests that annual growth rates are concentrated around 0.02 (2 per cent) with high peakendness. Figure 6.2 displays the distribution of undervaluation.

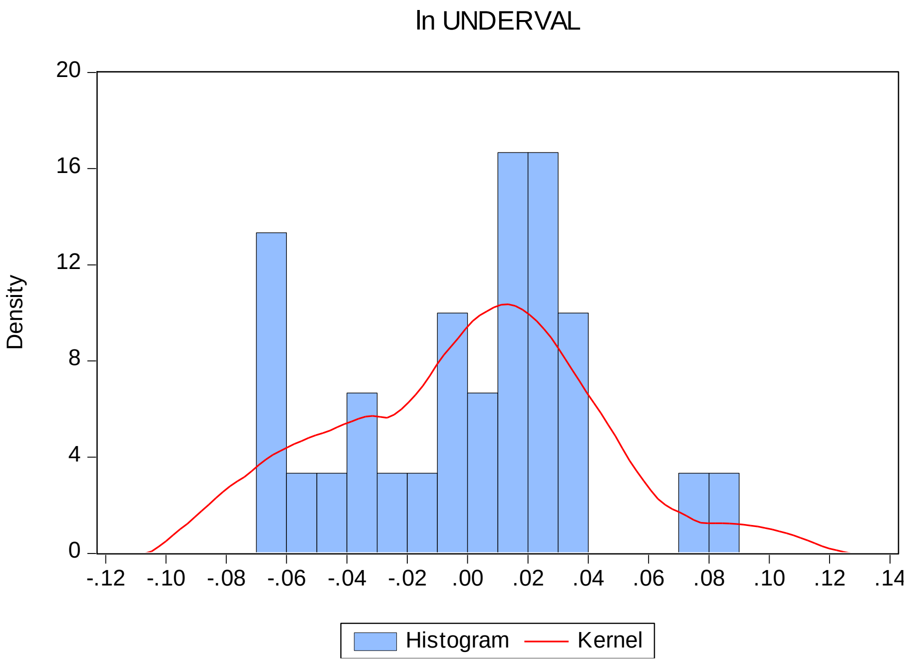


Figure 6.2: ln UNDERVAL Distribution (1985 – 2014)

Source: Computed Based on Data

The red line represents an epanechnikov kernel distribution evaluated with the linear binning method. A bell shaped distribution does emerge from the Balassa-adjusted measure of undervaluation although there is some evidence of extreme data points. Figure 7.1 presents a scatter plot which graphs side by side our measure of undervaluation and sectoral growth over each 5 year period. Each sector therefore enters with 6 data points which represent 6 5 year averages. The idea is to infer informally the partial correlation between initial undervaluation and subsequent growth for a 5 year non-overlapping window. It can be inferred from figure 7.1 that sectoral growth is an increasing function of undervaluation. Higher growth coincides with a higher exchange rate which is a corroboration of a conclusion reached by Rodrik (2008). Although the figure partly exhibits presence of outlying observations, it will be shown in later sections that the positive correlation between undervaluation and growth is not at all driven by such atypical observations in the data.

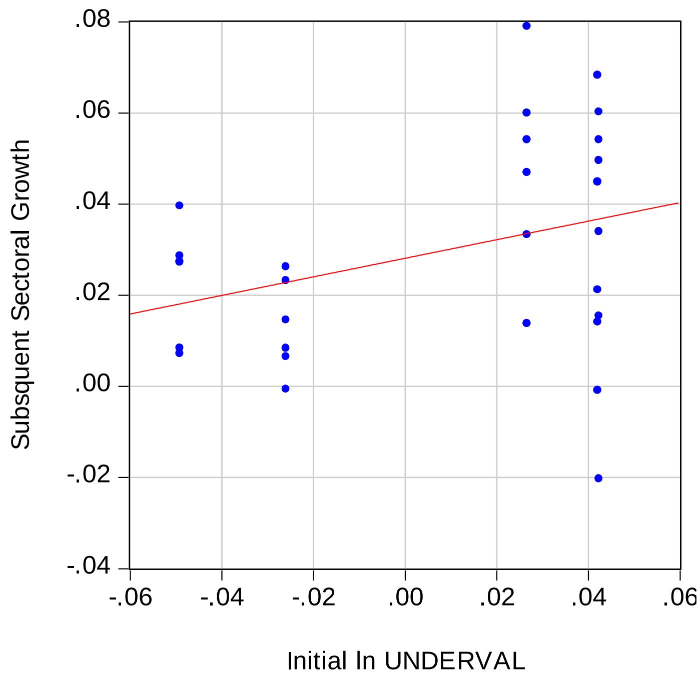


Figure 7.1: Initial Undervaluation and Sectoral Growth

Source: Computed Based on Data

The result in figure 7.1 needs however not to be interpreted with too much excitement for two reasons. The first is that it is not controlling for other determinants of sectoral growth and secondly it does little to address causality and therefore endogeneity issues. The latter reason which is causality emanates from misreading the direction. If we could run a controlled experiment, we would avoid the danger of reverse causality and to run that experiment, we would set the level of exchange rate undervaluation and then examine its correlation with growth. Figure 7.1 is not however based on such an experiment. What we have done is to simply observe that growth is higher when the exchange rate is undervalued. Nothing in the graph allows us to establish the direction of causality. The following sections provide empirical estimates which formally demonstrate the empirical link between undervaluation and sectoral growth while controlling for sector-specific input factors of production and addressing these causality problems.

5.2 Econometric Evidence

This section presents and discusses the econometric evidence. A combination of panel and time series techniques are employed although the former is considered the baseline approach. Unlike simple descriptive statistics, regression provides more systematic results in terms of relationships while controlling for other explanatory variables.

The first step was to check for collinearity problems among the independent variables. If variables are perfectly collinear, one can only estimate their joint effect otherwise it will be impossible to isolate their partial effects on the dependent variable. Documented in table 2.2 are pairwise correlation coefficients for the variables.

Table 2.2: Pairwise Correlation Matrix

	Growth	Initial Income	lnLabour	lnCapital	lnUNDERVAL
Growth	1				
Initial Income	-0.02	1			
lnLabour	0.31	0.45	1		
lnCapital	0.35	0.26	0.11	1	
lnUNDERVAL	0.34	-0.09	-0.03	-0.01	1

Generally, multicollinearity becomes a problem when its degree is high among variables with the common threshold used being, (but not always) 0.8. In this case, none of the correlation coefficients is close to 0.8 which diminishes concerns about perfect collinearity among variables. Encouraging is that the pairwise correlation coefficient between undervaluation and growth is positive suggesting that growth in sectors and undervaluation move in the same direction.

The next step is to check whether or not sectors are cross sectionally dependent and also whether the regressors are indeed endogenous to warrant the use of the system GMM estimation strategy. The former was performed by Pesaran cross sectional dependence test while the latter was performed by the Durbin Wu-Hausman test. For the sake of brevity, both tests are reported in table 3.1.

Table 3.1: Endogeneity and Cross Sectional Dependence

Test	**Test statistic**	**p-value**
Durbin Score chi2(1)	5.24	0.0410
Wu-Hausman	5.24	0.0193
Pesaran CD	0.97	0.3340

The null hypothesis of the Durbin Wu-Hausman test is that variables are exogenous. The probability value is less than 5 percent hence the null of variable exogeneity can be rejected. This means that the regressors are endogenous. With respect to the test for cross sectional dependence, the null hypothesis is that sectors are cross sectionally independent. The probability value is way above the maximum significance level hence the null cannot be rejected. This means that sectors are cross sectionally independent.

The system GMM estimation strategy maintains the assumption of cross sectional independence and is particularly appropriate in cases of endogenous regressors. Given that the variables are endogenous, not collinear and are cross sectionally independent, we can safely proceed with the system GMM estimation strategy.

Table 3.2 in this regard reports the subsequent impact on sectoral growth of a standard deviation change in each of the regressors. The dependent variable is average annual growth of a 5 year period. The estimation procedure is such that we start with results from the baseline estimation technique, the Blundell and Bond system GMM followed by alternative estimation techniques which are only considered for robustness check.

With respect to the baseline estimator, the system GMM, the standard errors are robust to heteroescedasticity to guard against potential efficiency loss and a one-step estimation approach is used. Also, time dummies are not included given their joint insignificance whenever they are controlled for in the model. Given the endonegeity of almost all of the variables as confirmed by the Durbin Wu-Hausman, all right handside variables were treated as endogenous variables in the system GMM.

The fixed effects model on the other hand was estimated using the within estimator which tracks the effect of each explanatory variable on growth within each sector. The alternative least squares dummy variable approach would lead to a loss of degrees of freedom due to inclusion of a dummy variable for each sector. As in the system GMM, the F-test for joint significance of time fixed effects did not suggest inclusion of time dummies in the fixed effects model.

Table 3.2: Undervaluation and Sectoral Growth in South Africa

Dependent Variable = Sectoral Growth				
	(1) **System GMM**	**(2)** **Fixed Effects**	**(3)** **Random Effects**	**(4)** **Pooled**
Growth -1	0.169			
	(0.178)			
Initial income	-0.019**	-0.016	-0.012	-0.015
	(0.009)	(0.050)	(0.020)	(0.013)
Initial lnUNDERVAL	0.177***	0.208**	0.204**	0.201*
	(0.061)	(0.093)	(0.086)	(0.098)
Initial lnCapital	0.041**	0.064	0.041*	0.032**
	(0.019)	(0.040)	(0.022)	(0.014)
Initial lnLabour	0.029*	0.046	0.025	0.025**
	(0.017)	(0.132)	(0.021)	(0.012)
Constant	-0.293	-0.547	-0.307	-0.234
	(0.129)	(0.603)	(0.169)	(0.106)
AR(1)	0.0460			
AR(2)	0.7346			
Sargan test	0.7367			
p-value	0.0000	0.1154	0.0307	0.0247
Time dummies	No	No	No	No

Note: *,**,*** denote $p < 0.1, p < 0.05$ & $p < 0.01$ respectively. Figures in paretheses are standard errors.

The coefficient attached to lagged sectoral growth is positive and less than infinity reflecting dynamic stability of the estimated model. Since the model is dynamically stable (i.e $|\rho| < 1$) then the mean growth rate is given is -0.35 obtained from ${-0.293}/{1 - 0.169}$ where -0.293 is the intercept from the estimated model. However, the coefficient of the lagged dependent variable is not significantly different from zero in a statistical sense hence we do find empirical support in favour of the hypothetical prediction of partial adjustment in sectoral growth.

With respect to the variable of main inquiry, it is quite encouraging that undervaluation carries a significant positive and sizeable effect on growth across all the four variants. In the baseline specification, the null hypothesis that undervaluation does not affect sectoral growth is strongly rejected with only 1 per cent chance of commiting a type 1 error (rejecting a true null hypothesis). According to the result, a percentage increase in undervaluation holding constant initial income, the level of employment and capital stock in each sector is estimated to raise the mean annual growth of a 5 year period by 0.177 percent on impact. This is a short-run effect since it does not take into account the lagged coefficient of the dependent variable. The long-run effect is therefore 0.21 which we observe after eliminating the autoregressive term $\left(\frac{0.177}{(1-0.169)}\right)$. The 95 per cent confidence interval of this point estimate (0.177 for the short-run and 0.21 long-run) is 0.056 and 0.298 for the lower and upper limit respectively implying that in many repeated samples, the true effect of undervaluation will appear between this interval 95 per cent of the time. Since 0 (which is hypothesised to be the population parameter) does not lie within this region, we reach the same conclusion with the significance level approach that undervaluation significantly explains sectoral growth.

Under alternative estimation strategies, the effect of undervaluation on sectoral growth is much more positive albeit with weak statistical significance. Interestingly enough, the pooled least squares does not significantly alter the size and magnitude of undervaluation. This is a remarkable result; what it says is that disregarding the panel nature of the dataset and the potential heterogeneity between the error term and the explanatory variables, undervaluation still affects sectoral growth significantly. An immediate impression that arises from this observation is that the way undervaluation interacts with sectoral growth may not be significantly influenced by the heterogeneity of these sectors (or sectoral differences). In other words, what this says is that it doesn’t matter whether one picks the agriculture or the mining sector, a positive correlation between undervaluation and growth emerges. However ss will be shown in later sections of this chapter in time series approaches, the effect of undervaluation is not at all uniform across these sectors. Some sectors seem to flourish while others are estimated to diminish in performance in response to currency undervaluation. This observation will be shown under time series techniques which tracks how undervaluation correlates with growth of specific sectors over time.

Overall however, it is fair to conclude from panel data inferences, that all three estimation techniques agree that undervaluation encourages subsquent growth of an average sector although the coefficient obtained from the fixed effects, random effects and the pooled least squares appear to have a slight upward bias. This could highlight the common weakness of the random and fixed effects modelling strategies in addressing endogeneity emanating from omitted time varying variables that may jointly and positively affect both sectoral growth and exchange rate undervaluation.

In terms of consistency, the positive and significant correlation between initial undervaluation and subsquent sectoral growth seems to empirically support Rodrik’s (2008) assertion that currency undervaluation is accompanied by rapid economic growth with tradable sectors being the transmission channel. The findings reinvigorate the undervaluation-led growth hypothesis which is also quite consistent with the majority of previous work that demonstrates a strong positive association between undervaluation and sectoral growth with dynamic panel data techniques (Rodrik, 2008) than with alternative static modelling approaches (Masunda, 2011).

Generally and empirically from the literature, countries that engage in policies that lead to currency appreciation are, in most cases, plausible candidates for slow growth. Likewise, sectors in countries that maintain overvalued exchange rates (low levels of currency depreciation in this case), are more likely to witness low growth rates. The results in table 3.2 suggest that undervaluing the local currency raises sectoral growth while overvaluing the local currency achieves the opposite.

This has been confirmed elsewhere. In Rodrik (2008) for instance, undervaluation is found to facilitate expansion of tradable activities particularly in the manufacturing sector. The argument raised there, which is applicable in our context, is that the manufacturing sector is largely tradable and therefore an undervalued exchange rate would encourage growth of the sector through promoting exports. Relative to non-tradable sectors, tradable sectors are not constrained by domestic demand. An undervalued currency subsidises producers in tradable sectors to produce and export on the world market leading to growth.

Finding a significant correlation between undervaluation and sectoral growth is however in sharp contrast to the results documented in Masunda (2011). Although our studies are not directly comparable given the different approaches used in computing real exchange rate undervaluation, a possible cause of contradiction could be the handling of endogeneity emanating from third variables. Masunda (2011) relied on the feasible generalised least squares approach which raises essentially the same issues as the pooled ordinary least squares estimation technique in the presence of endogeneity.

As the neoclassical growth theory predicts, the initial income coefficient is negative reflecting presence of conditional convergence among the sectors. Given the results in table 3.2, a poor sector in the sample is estimated to grow faster and catch up with richer sectors if the conditioning factors, exchange rate undervaluation, employment and capital stock, are in reasonably good shape. This is particularly true when considering results from the baseline specification where the initial income coefficient happens to be statistically significant otherwise results from the fixed effects, random effects and pooled least squares are not very supportive of the conditional convergence despite bearing the correct negative sign. This observation is fairly intuitive given the inability of alternative estimation techniques to handle endogeneity issues. Sector-specific input factors, labour and capital, all enter with the expected positive signs predicted by the neoclassical growth theory. Accumulation of capital is theoretically expected to increase output and growth assuming that the law of dimishing marginal returns does not set in. This asertion is substantiated by the results in table 3.2. In the baseline specification, a 10 percent increase in capital is estimated to raise average annual growth of a 5 year window by 0.4 percent holding constant labour, undervaluation and initial income. A similar result is documented in Masunda (2011) in the context of Zimbabwe.

Labour turns out to be positive as one would expect but the effect is only statistically significant in two out of four cases. This should not come as a surprise given that by measurement, this variable is capturing the quantity not quality of labour. The model confirms the presence of first order serial correlation but rejects second order serial correlation which makes the instruments relevant. On the other hand, the probability value of the Sargan test is above the 10 percent maximum significance level implying that the instruments utilised in the system GMM are indeed valid. The F-test for joint significance of time dummies is not significantly different from zero hence time dummies were not included. With respect to the pooled least squares (POLS), the model rejects heteroscedasticity but confirms the presence of omitted variables. The later result could refelect presence of omitted sector specific time-invariant factors given the inability of POLS technique to consider the panel nature of data.

A customary practice in literature is to test the sensitivity of regression estimates to changes in the estimation techniques and variable measurement. As shown in table 3.2, changing the estimation technique does not significantly alter the association between undervaluation and sectoral growth. For the fixed and random effects, one would need to perform the Hausman specification test but this is not necessary in our case since the idea is to assess the estimates from both techniques as a robustness check of the result produced by the baseline estimator. Given that the system GMM is a dynamic model while the rest are static, the estimates are therefore not sensitive to model specification.

It is important however that Woodford (2009) criticises the Balassa-Samuelson effect adjusted measure of undervaluation. He argues that by construction, this variable suffers from measurement error which could exaggerate the association between undervaluation and growth. This measurement error arises from regressing the real exchange rate on income per capita in a bid to control for the Balassa-Samuelson effect. To test whether this limitation influences the results, table 4.1 presents estimates with an undervaluation measure that is not adjusted for the Balassa-Samuelson effect.

The results from fixed and random effects are not very encouraging in the sense of their having a considerable number of insigificant variables although undervaluation still enters with the consistent positive sign. Undervaluation only enters significantly in the baseline estimator otherwise the coefficient is not significantly different from zero in a statistical sense in alternative estimation techniques despite having the correct sign. These findings reiterate the importance of controlling for endogeneity of third variables captured in the error term. A noteworthy result from this robustness check is the substantial decrease in the size of the undervaluation coefficient. The Balassa-Samuelson effect adjusted measure of undervaluation in table 3.2 produced a 0.177 which is not only sizeable but also highly significant as compared to the 0.015 documented in table 4.1 when using the unadjusted measure which is significant at 5 percent. This result corroborates Woodford's (2009) argument that Rodrik's (2008) measure adjusted for the Balassa-Samuelson effect exaggerates the association between undervaluation and growth. Other regressors only enter significantly in the pooled least squares.

Table 4.1: Estimates of the Unadjusted Undervaluation Measure

Dependent Variable = Sectoral Growth				
	(1)	**(2)**	**(3)**	**(4)**
	System GMM	**Fixed Effects**	**Random Effects**	**Pooled**
Growth -1	-0.025			
	(0.142)			
Initial income	-0.011***	-0.006	-0.009	-0.008
	(0.003)	(0.022)	(0.008)	(0.006)
Initial lnUNDERVAL	0.015**	0.026	0.015	0.014
	(0.006)	(0.024)	(0.019)	(0.019)
Initial lnCapital	0.015**	-0.034	0.009	0.009*
	(0.006)	(0.057)	(0.008)	(0.005)
Initial lnLabour	0.016***	0.030	0.015*	0.014**
	(0.003)	(0.021)	(0.009)	(0.006)
Constant	-0.114	0.050	-0.088	-0.086
	(0.038)	(0.237)	(0.066)	(0.044)
AR(1)	0.0314			
AR(2)	0.4850			
Sargan test	0.5290			
p-value	0.0000	0.6216	0.3098	0.0582
Time dummies	No	No	No	No

Note: *,**,*** denote $p < 0.1, p < 0.05$ & $p < 0.01$ respectively. Figures in paretheses are standard errors.

The baseline regression model shows a systematic tendency of sectors that start off poor to growth faster and converge towards richer sectors and the convergence rate is estimated to be around 1.1 percent per year. This convergence is conditioned on undervaluation, employment and capital stock in each respective sector. The overall probability value indicates that jointly, all regressors in the baseline regression model are statistically significant at the 1 percent significance level. Again, time dummies entered insignificantly and could therefore not be included to avoid unnecessary model overfitting.

The next robustness check is a different measure of undervaluation. The first two measures, both the Balassa-Samuelson adjusted and the unadjusted measure, are based on the price level. An alternative measure considered is that which is derived from the notion of finding an equilibrium real exchange rate. This approach assumes a small open economy where the real exchange rate is affected by a set of fundamentals that ensures both internal and external balance. The real exchange rate is then undervaluaed if the prevailing real exchange rate is below the equilibrium real exchange rate suggested by the fundamentals. The first step was to compute the equilibrium real exchange rate model as outlined in the previous chapter. The model was estimated using the Stock and Watson dynamic ordinary least squares technique with 1 lead and 2 lags selected based on information provided by the AIC. The results of this equilibrium real exchange rate model are not presented here but can be found in appendix E since the objective was only to compute an alternative measure of undervaluation. Having estimated this equilibrium real exchange rate model, the total sample was then decomposed so that we could focus only on periods in which the prevailing exchange rate was less than the equilibrium real exchange rate. Decomposing the sample this way results in an enormous loss of degrees of freedom but the cost is not very damaging due to the panel nature of data which can still give a reasonable sample size.

An alternative approach was to invoke the dummy variable approach as did Brixiova and Ncube (2014). The dummy would take the period in which the real exchange rate is undervalued and zero otherwise. This approach has two limitations. The first is that the dummy variable makes it difficult to separate the effects of undervaluation from those of other policy developments that may have taken place during the same period. The second limitation is that including a dummy as an endogenous variable in the system GMM is not feasible due to the first difference data transformation that takes place. Table 4.2 therefore reports results in which the sample was limited to undervaluation episodes.

The initial income coefficient is now negative and significant across all variants indicating a systematic tendency of conditional convergence. The lagged growth term remains statistically insignificant implying a lack of partial adjustment. Encouraging is that the undervaluation measure derived from a model-based approach enters with a positive and statistically significant sign across all variants which confirms the results obtained in the case of Rodrik's (2008) Balassa-Samuelson adjusted measure. One immediate observation that emerges in table 4.2 is that the coefficient attached to a model-based measure of undervaluation is lower in terms of size relative to the baseline measure of undervaluation.

Table 4.2: Estimates of the Model-Based Measure of Undervaluation

Dependent Variable = Sectoral Growth				
	(1)	**(2)**	**(3)**	**(4)**
	System GMM	**Fixed Effects**	**Random Effects**	**Pooled**
Growth -1	-0.077			
	(0.138)			
Initial income	-0.027***	-0.146***	-0.040***	-0.019***
	(0.010)	(0.035)	(0.014)	(0.007)
Initial lnUNDERVAL	0.027***	0.043**	0.030**	0.026**
	(0.007)	(0.012)	(0.012)	(0.013)
Initial lnCapital	0.034***	0.248**	0.029*	0.021***
	(0.013)	(0.104)	(0.015)	(0.006
Initial lnLabour	0.012	0.027	0.010	0.011
	(0.016)	(0.025)	(0.015)	(0.008)
Constant	-0.110	-0.767	0.004	-0.077
	(0.106)	(0.483)	(0.118)	(0.060)
AR(1)	0.0823			
AR(2)	0.2119			
Sargan test	0.2841			
p-value	0.0000	0.0004	0.01352	0.0030
Time dummies	No	No	No	No

Note: *,**,*** denote $p < 0.1, p < 0.05$ & $p < 0.01$ respectively. Figures in paretheses are standard errors.

For the Balassa-Samuelsson adjusted measure, a 10 percent increase in undervaluation was estimated to raise the average annual growth of a 5 year period by a margin of 1.77 percent. This time, the model-based measure shows a 0.27 percent increase in average annual growth of a 5 year window in response to every 10 percent increase in undervaluation holding constant labour, capital and initial income (in the baseline case). This result suggests that it is the size not the sign of undervaluation that is sensitive to the measure of undervaluation used.

Labour and capital still enter with their expected positive signs but only capital enters significantly. By raising the level of capital stock by a 10 percent margin, the baseline regression model predicts a 0.34 percent rise in sectoral growth all else being equal. Labour although consistent, does not have a significant effect on growth across all the four variants and this may highlight the importance of measuring labour in terms of skill rather than the number of workers. The overall probability values indicate that the explanatory variables jointly affect sectoral growth. The baseline regression model does not suffer from weak instruments given the presence of first order serial correlation and the absence of second order serial correlation. The Sargan test having a probability value above the 10 percent mark implies that the instruments utilised in the system GMM are valid. Until now within a panel data framework, the analysis is assuming that undervaluation has a linear effect on sectoral growth or that the association between undervaluation and growth exists in a straight line. Some studies (Béreau et al., 2012, Aflouk and Mazier, 2011) challenge this assumption. They argue and show that undervaluation correlates with growth in a nonlinear fashion implying presence of a turning point in correlation. To test these predictions, we add in the model a quadratic term of undervaluation and observe its behaviour in terms of both the sign and statistical significance. The results of this exercise are reported in table 5.1.

Table 5.1: Nonlinearities of Undervaluation and Sectoral Growth

Dependent Variable = Sectoral Growth				
	(1) **System GMM**	**(2)** **Fixed Effects**	**(3)** **Random Effects**	**(4)** **Pooled**
Growth -1	-0.049			
	(0.137)			
Initial income	-0.008***	0.115	-0.005	-0.007
	(0.003)	(0.025)	(0.009)	(0.007)
Initial lnUNDERVAL	0.027***	0.022	0.026	0.027
	(0.009)	(0.024)	(0.021)	(0.019)
Initial lnUNDERVAL^2	-0.032**	-0.040	-0.030	-0.029*
	(0.012)	(0.027)	(0.020)	(0.014)
Initial lnCapital	0.014**	-0.004	0.008	0.009***
	(0.006)	(0.061)	(0.008)	(0.005)
Initial lnLabour	0.016***	0.020	0.014	0.013**
	(0.004)	(0.022)	(0.009)	(0.005)
Constant	-0.130	-0.153	-0.102	-0.029
	(0.044)	(0.275)	(0.066)	(0.041)
AR(1)	0.0310			
AR(2)	0.3827			
Sargan test	0.5842			
p-value	0.0000	0.4520	0.2152	0.0069
Time dummies	No	No	No	No

Note: *,**,*** denote $p < 0.1, p < 0.05$ & $p < 0.01$ respectively. Figures in paretheses are standard errors.

With respect to the baseline regression model estimated by the system GMM approach, the linear term of undervaluation remains positively and significantly signed. In the case of fixed, random and pooled least squares techniques, the coefficient on the variable capturing the linear effect of undervaluation is positively signed but the effect is not statistically significant. The reason could be that the linear effect of undervaluation is estimated less precisely (given higher standard errors) under alternative estimation techniques as compared to the system GMM which controls for endogeneity.

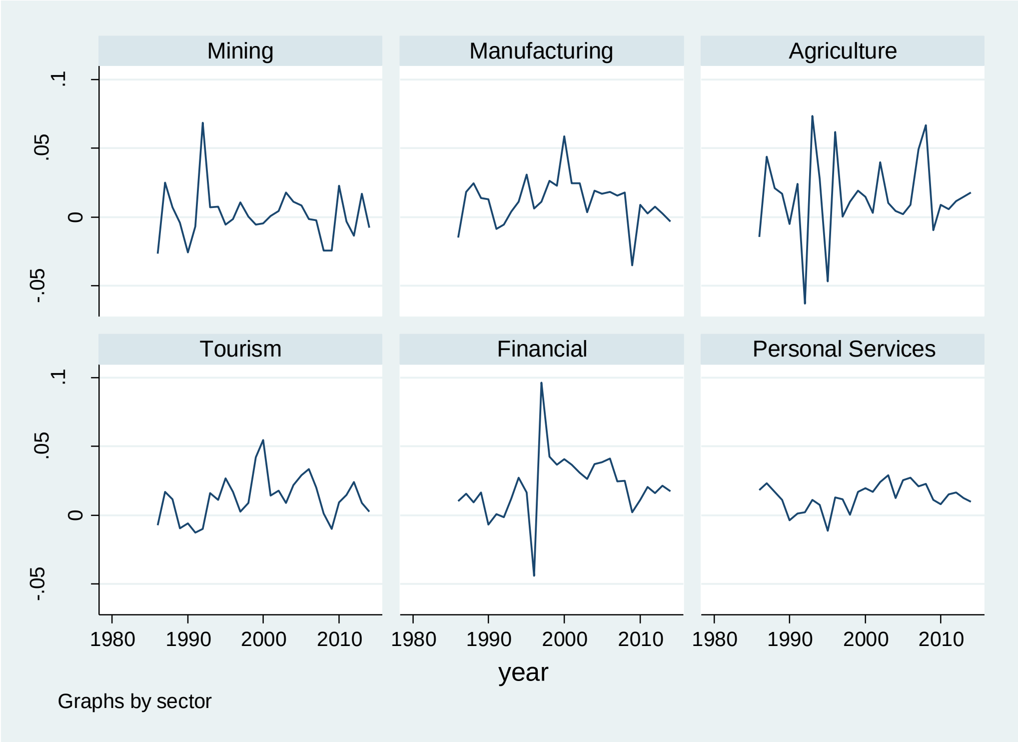
Turning to the quadratic term of undervaluation, the results from the baseline model are supportive of a nonlinear (inverted U-shaped) relation between undervaluation and sectoral growth. The nonlinear term is negative and statistically significant in the system GMM framework suggesting that increasing undervaluation will raise growth up to a certain turning point where further undervaluation of the local currency negatively affects growth. This result lends support to Bereau, Villavicencio and Mignon (2009) and Couharde and Sallenave (2013) who find a positive effect of small to moderate undervaluations on growth while large undervaluations hurt growth.

The result is also in line with those confirmed in Calderon and Aguirre (2005). They found that undervaluation can cripple growth prospects of an economy if it exceeds 25 percent. The South African rand has accumulatively depreciated by close to 50 percent since 2011 against its major trading partners (SARB, 2015). Other regressors enter with correct signs, except for capital which, for the first time enters with a negative albeit statistically insignificant effect. Overall, the results from alternative estimation are rather disappointing. Most of them seem to estimate insignificant effects of the regressors, with the exception of the pooled least squares which has three significant variables out of five.

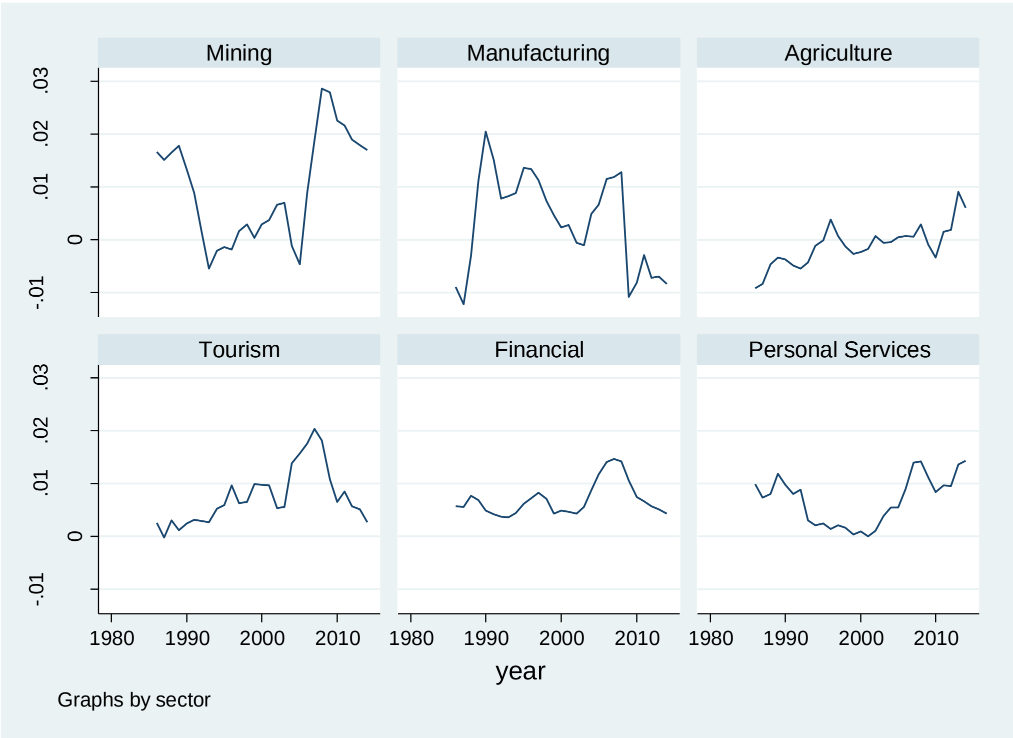
We also experimented by adding concurrently two interaction terms in the model 1) undervaluation and sectoral employment and 2) undervaluation and capital stock in each sector. This experiment simply uses capital stock and the number of workers employed in each sector as moderator variables governing how undervaluation interacts with sectoral growth. The result emerging from this experiment is quite insightful in that only the latter interaction enters with a significant positive sign. What this implies is that undervaluation has a more relevant and sizeable effect in sectors that accumulate more capital stock as opposed to those that employ more labour. This finding is in line with Mbaye (2012) and Levy-Yeyati and Sturzenegger (2003) who argue that undervaluation encourages growth through the capital accumulation channel rather than labour absorption. The argument is that the real exchange rate affects sectoral growth through its effect on savings. This hypothesis claims that an undervalued real exchange rate facilitates growth in sectors through an increase in capital stock that emanates from an increased savings rate. For the sake of brevity, the results of this exercise are attached in appendix D. The next section presents and discusses results from alternative data frequency (panel time series evidence).

5.3 Panel Time Series Evidence

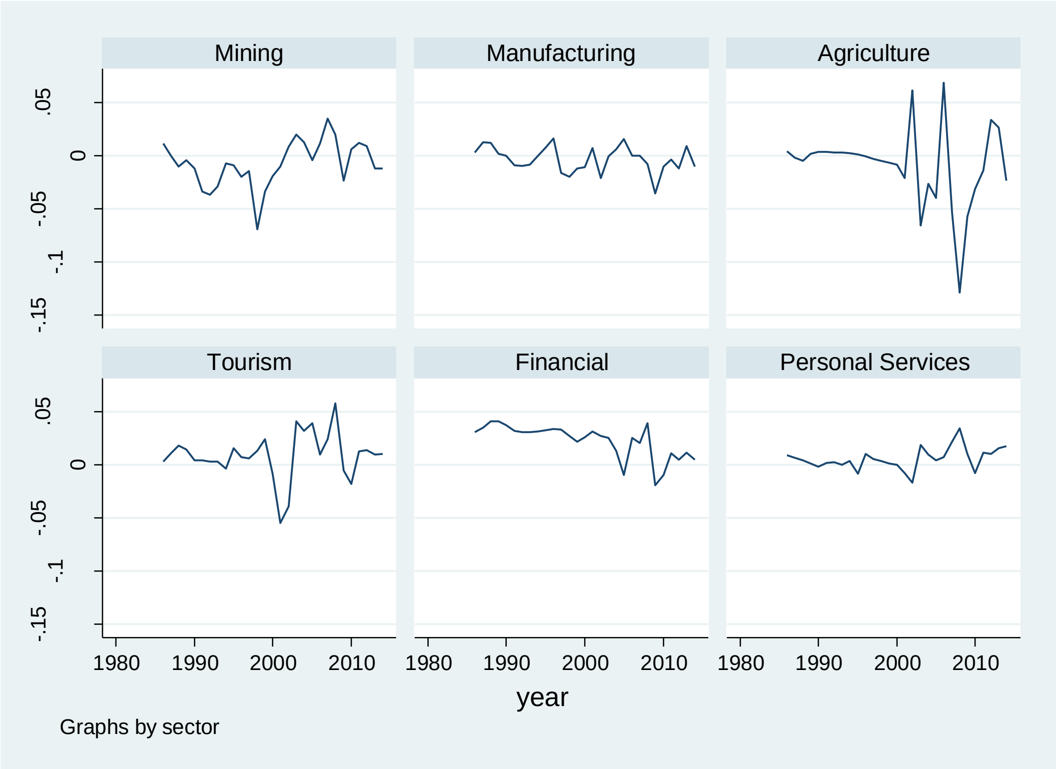
In this section, the goal is to test the sensitivity of results to changes in data frequency, theoretical model and estimation strategy. In this respect, annual data is used instead of 5 year averages while initial income is dropped to formulate a standard neoclassical growth function. The use of annual observations instead of 5 year averages in particular leads to a panel time series data set that is typically characterised by large T and small N. Consequently given a time dimension of about 29 years, concerns of panel non-stationarity naturally surface. To avoid running spurious regressions against the above background, We first carefully examine the underlying data generating process of the variables. Examining the underlying data generating process in particular requires a look at the stationarity property of our data. To achieve this, both informal and formal approaches are employed. The former consists of using some eyeball techniques to infer whether or not a variable is generated by a unit root process. Figure 7.2 in this regards presents line graphs of each variable for each sector in the sample.



Mining
Manufacturing
Agriculture
Tourism
Financial
Personal Services
-.05
0
.05
.1
1980
1990
2000
2010
year
Graphs by sector



Mining
Manufacturing
Agriculture
Tourism
Financial
Personal Services
-.01
0
.01
.02
.03
1980
1990
2000
2010
year
Graphs by sector



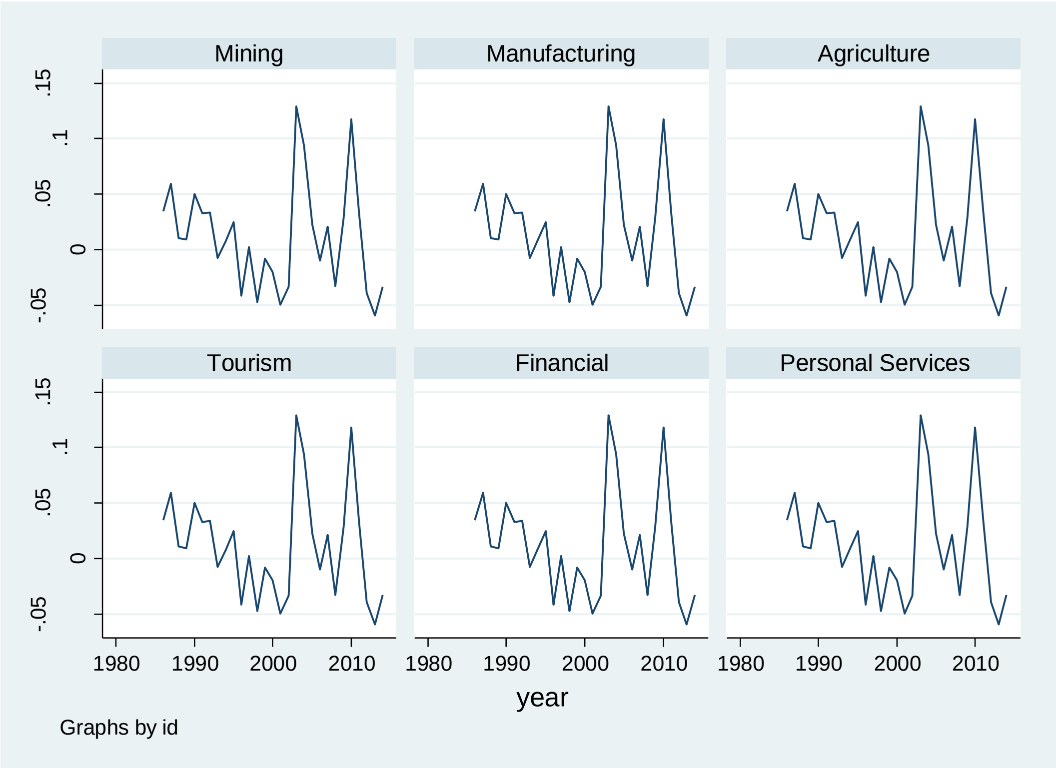


Figure 7.2: Informal Stationarity Tests by Sector

Source: Computed Based on Data

All the variables are sector-specific except our measure of undervaluation which is an economy-wide variable. Visually, capital and undervaluation appear to have an increasing variance while labour seems to fluctuate around a constant mean. Also, capital exhibits an upward trend in the case of the agriculture and tourism sectors. From informal inferences, one can render capital and undervaluation as a non-stationary while growth in sectors and labour appear to follow a stationary process.

These inferences are however informal and therefore conclusions cannot be made with any certainty. To get an accurate picture regarding the stationary properties of variables, table 5.2 presents results from formal unit root tests. We estimated separately first generation tests and second generation tests. In total, we performed 6 panel unit root tests, with first generation and second generation tests having 3 apiece. The former tests do not accommodate potential cross sectional dependence among sectors while the latter is quite robust to this potential problem. In both cases however, variables seem to be non-stationary in levels and stationary after first differencing. We considered specifications with and without a trend and intercept but for brevity, only results for specifications with the intercept are presented. Important is that inclusion and exclusion does not change significantly the outcome of the tests.

Table 5.2: First Generation Panel Stationarity Tests

		Levin-Lin-Chu	**Im-Pesaran-Shin**	**Harris-Tzavalis**
lnGDP	Levels	-2.358***	-1.750	1.383
	1^{st} Δ		-4.628***	-8.317***
	Integration	I(0)	I(1)	I(1)
lnCapital	Levels	0.612	-0.678	4.002
	1^{st} Δ	-2.358***	-4.628***	-6.263***
	Integration	I(1)	I(1)	I(1)
lnLabour	Levels	-0.373	-1.054	2.401
	1^{st} Δ	-4.784***	-4.352***	-5.214***
	Integration	I(1)	I(1)	I(1)
lnUNDERVAL	Levels	0.323	-1.894	0.042
	1^{st} Δ	-9.506***	-3.445***	-6.380***
	Integration	1(1)	I(1)	I(1)

$Note$: $* \ p < 0.1, ** \ p < 0.05$ & $*** \ p < 0.01$

Table 6.1: Second Generation Panel Stationarity Tests

		Pesaran	**Breitung**	**Hadri**
LnGDP	Levels	-1.365	0.286	17.969***
	1^{st} Δ	-4.060***	-5.005***	0.1414
	Integration	I(1)	I(1)	I(1)
LnCapital	Levels	-0.046	3.798	19.415***
	1^{st} Δ	-4.060***	-2.343***	0.1420
	Integration	I(1)	I(1)	I(1)
LnLabour	Levels	-1.640	1.380	26.183***
	1^{st} Δ	-3.643***	-4.684***	1.123
	Integration	I(1)	I(1)	I(1)
lnUNDERVAL	Levels	2.610***	-0.461	27.179***
	1^{st} Δ		-1.893**	-0.654
	Integration	1(0)	I(1)	I(1)

$note$: $*\ p < 0.1$,$**\ p < 0.05$ & $***\ p < 0.01$

With the exception of the Hadri test, all the panel unit root tests have a null of a unit root. Included in the table are test-statistics for each test. These test statistics were compared against the 1, 5 and 10 percent critical values and a test statistic above any of these critical values would warrant rejection of the null in favour of the alternative. As tables 5.2 and 6.1 indicate, most tests do not reject the null of non-stationarity in levels and only reject them after first differencing (1^{st} Δ). The Hadri test on the other hand strongly rejects the null of stationary panels in levels. One can therefore conclude from the results that we are dealing with non-stationary panels overall and that cross sectional dependency is not very important in influencing the outcome of the results. Having non-stationary panels at hand, we proceeded with cointegration tests to determine whether or not these variables move together in the long-run. In line with the methodology, tables 6.2, 7.1, 7.2, and 8.1 reports results from 4 cointegration tests. The results are quite comforting. All 4 tests suggest the existence of a cointegrating relationship among the variables.

Table 6.2: Pedroni Test for Cointegration

Alternative hypothesis: common AR coefficients. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.434593	0.6681	-1.042622	0.8514
Panel rho-Statistic	-3.676536	0.0001***	-1.942845	0.0260**
Panel PP-Statistic	-11.96667	0.0000***	-7.573549	0.0000***
Panel ADF-Statistic	-5.837496	0.0000***	-3.928122	0.0000***

Alternative hypothesis: individual AR coefficients. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	-1.604303	0.0543*
Group PP-Statistic	-10.37321	0.0000***
Group ADF-Statistic	-5.025131	0.0000***

$note$: $*\ p < 0.1, **\ p < 0.05$ & $***\ p < 0.01$

Table 7.1: Westerlund Test for Cointegration

Statistic	**Value**	**Z-value**	**P-value**
$\mathbf{G_t}$	-3.477	-4.229	0.000***
$\mathbf{G_a}$	14.470	-2.611	0.005***
$\mathbf{P_t}$	-10.535	-5.577	0.000***
$\mathbf{P_a}$	-17.888	-5.282	0.000***

$*\ p < 0.1, **\ p < 0.05$ & $***\ p < 0.01$

Table 7.2: Kao Test for Cointegration

	t-Statistic	Prob.
ADF	-4.548115	0.0000***
Residual variance	0.000793	
HAC variance	0.000275	

$note$: $*\ p < 0.1, **\ p < 0.05$ & $***\ p < 0.01$

Table 8.1: Johansen and Fischer test for Cointegration

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	67.54	0.0000	44.78	0.0000***
At most 1	27.58	0.0064	27.58	0.0064**
At most 2	15.38	0.1131	18.11	0.1124

$note$: $** \ p < 0.05$ & $*** \ p < 0.01$

The null hypothesis of no cointegration under the Pedroni test is rejected at the 10 percent significance level in 6 out of 7 cases. Similarly, the null of no cointegration is strongly rejected under the Kao test pointing to a long-run relationship among the non-stationary variables. The Westerlund test also rejects at 1 per cent level the null of no cointegration which confirms the results of the Kao and Pedroni tests.

Lastly, the first null of no cointegrating relationship among variables is strongly rejected under the Johansen and Fischer test. The second null hypothesis of at most 1 cointegrating relationship is also rejected at the 1 per cent level. In the third case, the null of at most 2 cointegrating relationship cannot be rejected at the 10 per cent level both under the trace test and the max-eigen test. Combined together, all the cointegrating tests are pointing to a long-run relationship among the variables. Since we are dealing with non-stationary and cointegrating variables, a lot of information will be lost if we attempt to transform the variables into first differences. Rather, we estimate the model using cointegrating dynamic estimation techniques, the DOLS, FMOLS and the PMG.

The DOLS is estimated using 1 lag and 1 lead. On the other hand, both the DOLS and the FMOLS are estimated using the grouped estimation approach since it is more efficient relative to the pooled and weighted estimation approaches. Post estimation residual checks indicate that the residuals are normally distributed and a full set of these results is attached in appendix B. Table 8.2 reports the long-run estimates. In all three cases, undervaluation enters with a positive and highly significant effect. Interesting is that across all the variants, the size of the undervaluation coefficient is quite similar to that reported by the baseline estimator the system GMM estimator.

Table 8.2: Long-run Parameter Estimates

	DOLS	FMOLS	PMG
lnLabour	0.898***	0.193***	-0.052
	(0.208)	(0.019)	(0.181)
lnCapital	1.188***	1.053***	0.479
	(0.227)	(0.016)	(0.422)
lnUNDERVAL	0.294***	0.244***	0.226***
	(0.054)	(0.047)	(0.065)
Observations	162	174	90

Note: *,**,*** denote $p < 0.1, p < 0.05$ & $p < 0.01$ respectively. Figures in paretheses are standard errors.

With respect to the DOLS technique, a 10 per cent increase in exchange rate undervaluation translates into a 2.94 per cent increase in growth holding constant capital and labour. Similarly, growth is expected to rise by a margin of 2.4 per cent in response to a 10 per cent increase in undervaluation with respect to the FMOLS technique. Finally, the PMG predicts a 2.26 per cent increase in sectoral growth if the exchange rate undervaluation is increased by 10 per cent. Interesting is that the effect of undervaluation is similar and highly significant across the three different estimation strategies.

The estimation strategies employed up to this point, the system GMM, the DOLS, and the FMOLS indicate a positive and sizeable effect of undervaluation on sectoral growth. We show however that undervaluation promotes growth only in the mining sector and that undervaluation is harmful to growth of other sectors in the longer-run. To demonstrate this finding, we first present results from two panel strategies, the Augmented Mean Group (AMG) devised by Pesaran (2001) and the Common Correlated Effects (CCE). In both cases, we estimate using robust standard errors to guide against the potential loss of efficiency if heteroscedasticity is prevalent in the model.

Because we are interested in showing how undervaluation interacts with growth of individual sectors, we only present estimates from individual groups not the overall weighted estimates. Both under the AMG and CCE, undervaluation interacts positively and significantly with growth in the mining and services sector. Later sections will however further demonstrate that this positive effect is limited to the mining sector otherwise the positive effect is not sustainable in the long-run when it comes to the personal services sector. On the other hand, evidence suggests that growth in other sectors is hampered by undervaluation. The results are reported in table 9.1.

Table 9.1: CCE and AMG Group-Specific Estimates

Sector	Augmented Mean Group	Common Correlated Effects
Mining	0.118*	0.147***
	(0.061)	(0.050)
Manufacturing	-0.105**	-0.041
	(0.041)	(0.038)
Agriculture	-0.089	-0.181**
	(0.069)	(0.071)
Tourism	-0.069**	-0.075**
	(0.034)	(0.031)
Financial	-0.060	-0.048
	(0.047)	(0.050)
Personal services	0.076***	0.110***
	(0.023)	(0.033)

Note: *,**,*** denote $p < 0.1, p < 0.05$ & $p < 0.01$ respectively. Figures in paretheses are standard errors.

A 10 per cent increase in undervaluation raises growth in the mining sector by 1.18 per cent and 1.47 per cent under the AMG and CCE estimation technique respectively. In terms of relevance, the positive effect is highly significant under the CCE estimator and marginally significant under the AMG estimation technique. Another sector that benefits from undervaluation is the personal services and in both cases, the coefficient is surprisingly highly significant.

Unfortunately, undervaluation whittles down growth of agriculture and manufacturing sectors, which are both highly tradable. The same is the case for the tourism sector. Growth in the financial sector falls in response to an increase in exchange rate undervaluation but the effect is not statistically different from zero. In other words, both the CCE and AMG estimation techniques suggests that undervaluation does not significantly affect growth in the financial sector. The next section interprets and discusses empirical evidence from time series approaches.

5.4 Time Series Techniques

This section presents time series evidence. Unlike panel data approaches, the use of time series allows us to answer the question, how does undervaluation affect growth of individual sectors? The merit of this approach is that we can identify those sectors which benefit most from undervaluation and probably those that are negatively affected by presence of currency undervaluation.

As an entry point to the main analysis, a common informal way of detecting the association between undervaluation and sectoral growth is to do a trend analysis which seeks to observe the co-movements between undervaluation and growth over time. Notable shortcomings of this informal approach are that we not able to control for the other relevant regressors that may affect sectoral growth. The advantage however is that by constructing time series plots of both undervaluation and sectoral growth; we can get a visual impression of how growth in sectors tracks undervaluation over time. To ascertain how initial undervaluation relates to growth in the subsequent year, the starting year for undervaluation is 1985 while that of sectoral growth is 1986.

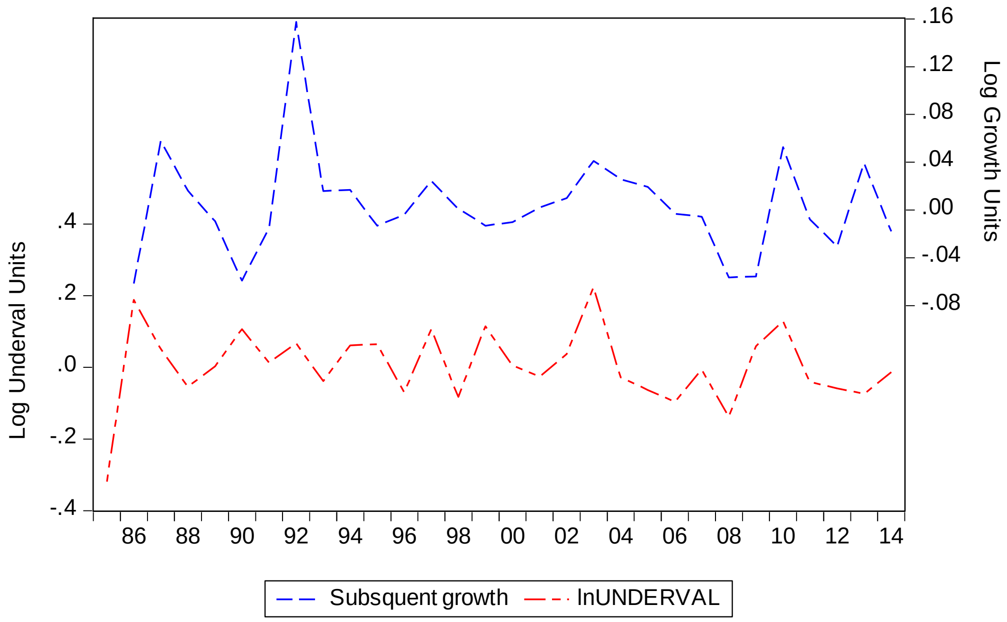


Figure 8.1: Undervaluation Effects on the Mining Sector

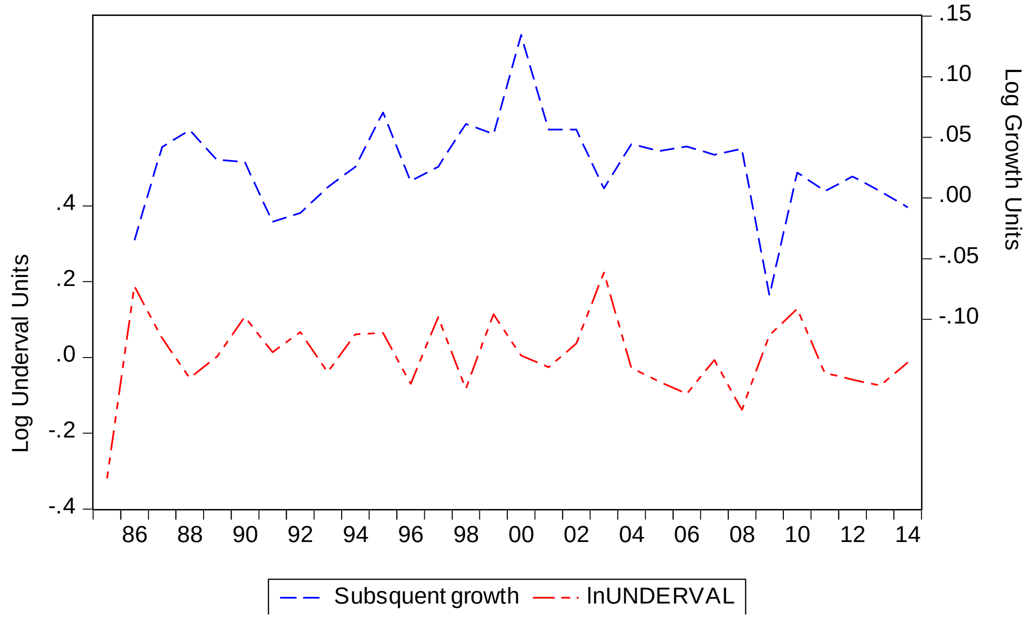


Figure 8.2: Undervaluation Effects on the Manufacturing Sector

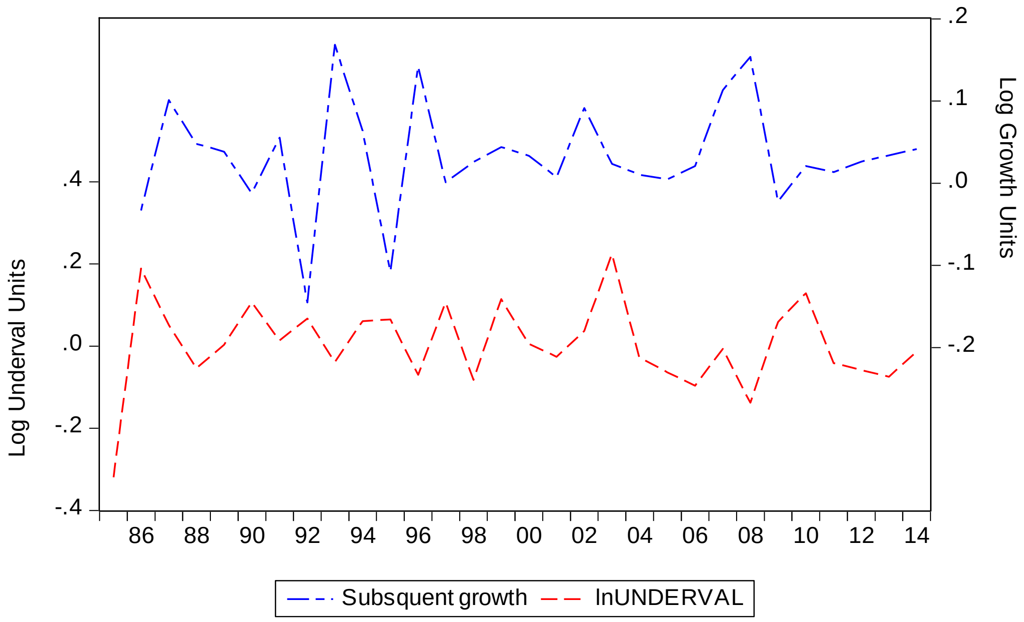


Figure 9.1: Undervaluation Effects on the Agriculture Sector

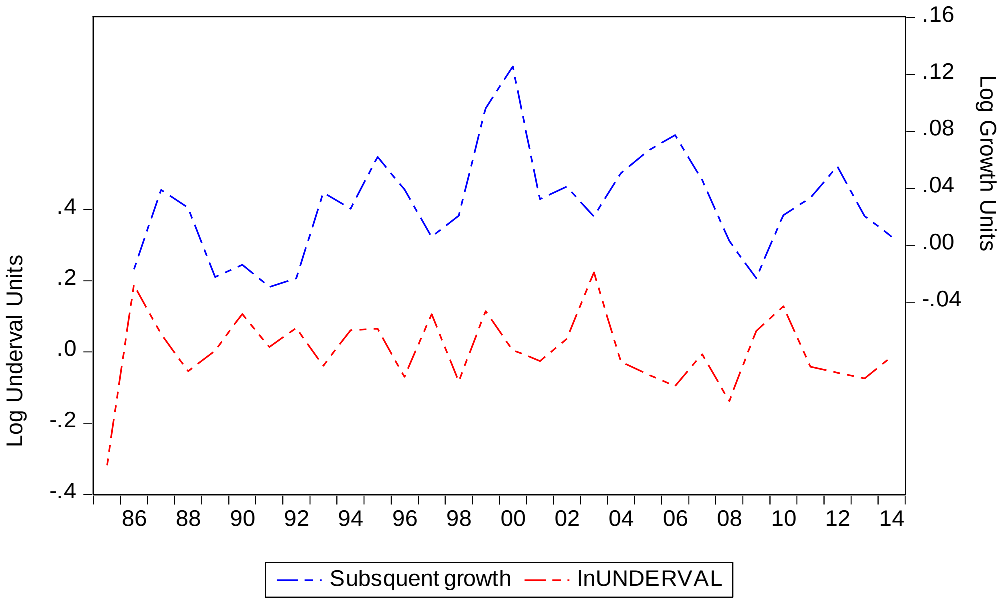


Figure 9.2: Undervaluation Effects on the Tourism Sector

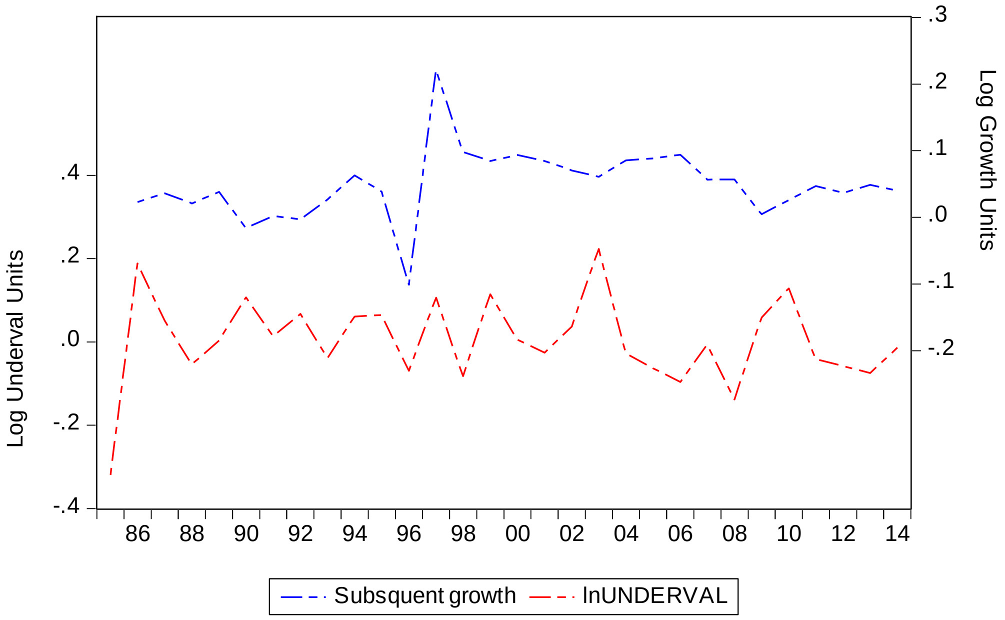


Figure 10.1: Undervaluation Effects on the Financial Sector

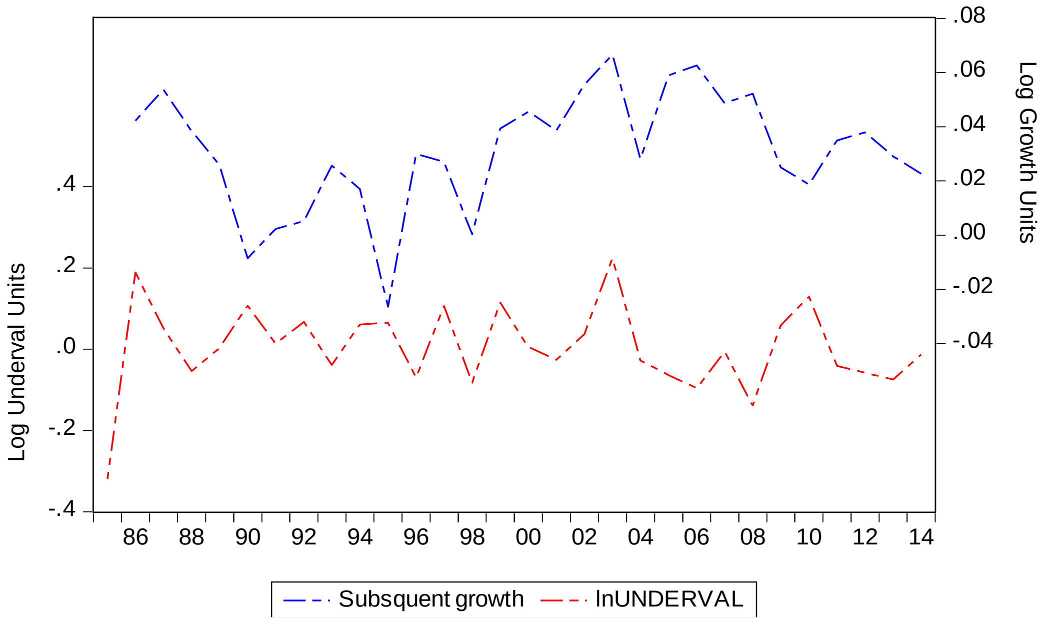


Figure 10.2: Undervaluation Effects on the Personal Service Sector

An increase in ln UNDERVAL reflects a depreciating local currency. Put differently, a decrease in ln UNDERVAL signifies an appreciating local currency. Therefore, an increase (decrease) in ln UNDERVAL can be viewed as an undervaluation (overvaluation) of the local currency. A visual inspection of all the figures reveals a positive co-movement between undervaluation and sectoral growth. The overall message is that undervaluing the local currency in the current period raises growth in the subsequent year.

This pattern is however more consistent in the case of the mining, agriculture and tourism sectors. In other words, the positive co-movement between undervaluation and growth is much more systematic and apparent in the mining, agriculture and the tourism sector. For other sectors, it is either the exhibition of some negative co-movements or that the positive co-movements are less systematic and not consistent over time.

The picture is less clear cut for the financial sector but there appears to be some parallel decrease in both undervaluation and growth of the financial sector in the mid-90s. The slight weakening of the local currency as indicated by a rise in the undervaluation measure in figure 10.1 in 1996 was accompanied by a huge boost in financial sector growth. This is plausible in the sense that a weakening local currency is generally followed by a tightening monetary policy which raises interest rates and promotes financial investment leading to growth of the sector.

Surprisingly on the other hand, the degree to which growth in the community and personal service sector (which has often been neglected in earlier studies) tracks undervaluation is uncanny. This sector generally engages in international trade at the margin but figure 10.2 displays a strong positive correlation between undervaluation and growth of the community and personal service sector. This positive correlation shows up from 1985 up to 2000 and disappears from 2001 onwards suggesting that an inflation targeting regime might have destroyed or at least weakened this association. The co-movements between undervaluation and growth in the manufacturing sector provide somewhat mixed insights.

Moving on to econometric evidence, stationarity tests are first performed using the Bai Perron which accommodates structural breaks. Stationarity tests are very critical in time series analysis given the use of annual observations over a long period of time unlike 5 year averaged panel data. The Bai Perron breakpoint unit root tests are based on both intercept and trend plus intercept with an innovative outlier.

Results indicate that variables are integrated of different orders and this necessitated the use of the bounds testing procedure which is applicable irrespective of the order of variable integration. The results of this tests are attached in appendix J. On the other hand using k=3 and case 3 (intercept and no trend) at the 5 percent level, the results of the bounds testing procedure suggested presence of a long-run relationship among the variables in lagged levels for all the 6 sectors. In this regard, we could safely proceed to estimate both the long-run coefficients and the short-run dynamics. Results for the bounds test procedure are attached in appendix J.

Table 9.2 below reports the short-run effect of undervaluation and other regressors on growth of each sector. This table reports only the short-run dynamics and the long-impact of undervaluation on growth of each sector, which is the main variable of inquiry. Coefficients of other regressors can be found in appendix J. In the estimation procedure, the model selection of the ARDL in terms of lags for the short-run dynamics was based on information provided by the SIC.

The probability values of the Ramsey RESET tests are greater than 10 percent implying that all the models are correctly specified. On the other hand, autocorrelation is found to be prevalent in the case of the mining and community and personal service sectors. In the presence of autocorrelation, the use of the OLS technique leads to unbiased, consistent but inefficient estimates both in small samples and large samples.

As a corrective measure therefore, these two models, one for the mining sector and the other for the community sector, were estimated with heteroscedasticity and autocorrelation consistent (HAC) standard errors. Other diagnostic tests that include heteroscedasticity, residual normality and CUSUM test for parameter stability are attached in appendix J; none of these assumptions was violated.

Table 9.2: Undervaluation and Sectoral Growth in South Africa (1985-2014)

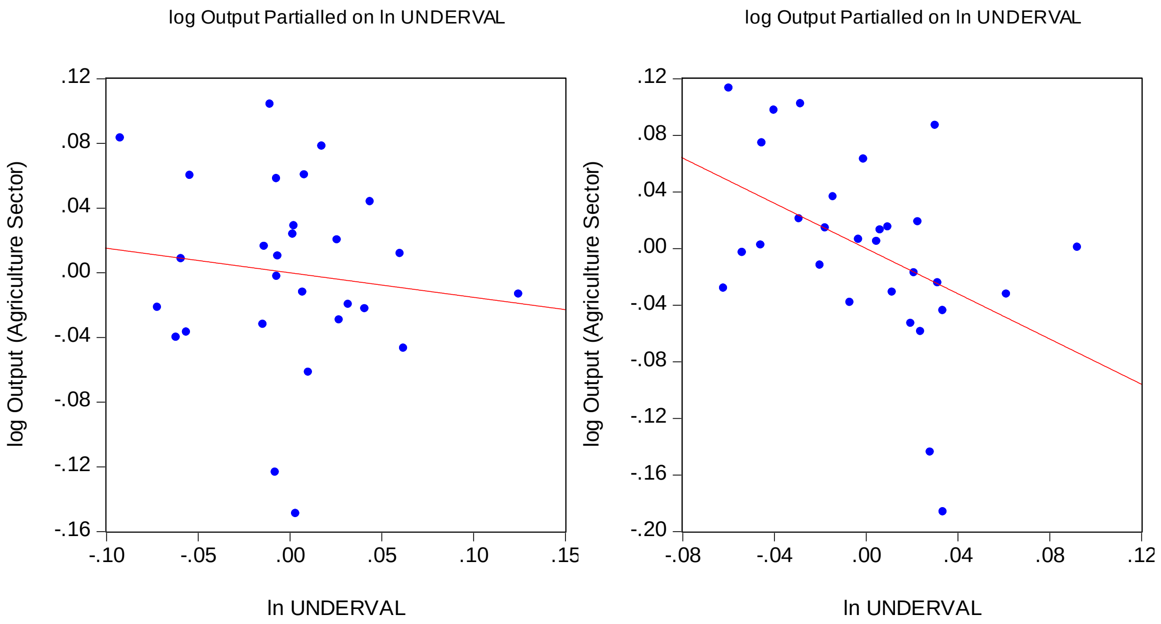
Sector	**ln UNDERVAL**			**Diagnostic**	**Tests**
	Short-run estimate	ECT	Long-run estimate	Serial LM test	Ramsey RESET test
Agriculture	-0.599**	-0.401***	-0.414**	0.9181	0.3828
	(0.252)	(0.104)	(0.168)		
Tourism	0.824***	-0.906***	-2.976***	0.6044	0.4190
	(0.131)	(0.172)	(0.470)		
Financial	0.815**	-0.643***	-2.607**	0.4727	0.5450
	(0.302)	(0.175)	(1.048)		
Manufacturing	-0.323***	-0.154***	-2.097***	0.9080	0.4129
	(0.100)	(0.050)	(0.440)		
Mining	0.284***	-0.494***	1.068**	0.0837*	0.8704
	(0.099)	(0.157)	(0.404)		
Personal services	0.323***	-0.911***	-0.858***	0.0213*	0.2906
	(0.066)	(0.153)	(0.147)		

Note: *, **, *** denote $p < 0.1, p < 0.05 \& p < 0.01$ respectively. Standard errors are in parentheses

In table 9.2, ECT is the error correction term which serves to correct any disequilibrium that may occur in the short-run. In all cases, the ECT has the correct negative sign and is statistically significant which reconfirms presence of a long-run relationship among the variables. Illustratively, the ECT for agriculture demonstrates that about 40 percent of a short run discrepancy is corrected in the current year.

Therefore, it takes about 2 and half years (100/40.1) for a short-run disequilibrium to completely disappear in the agriculture sector. In terms of comparison, the speed of adjustment is highest in the tourism sector and lowest in the manufacturing sector. Moving on to the results of the main inquiry, table 9.2 clearly indicates that the effect of undervaluation on growth is not uniformly distributed across sectors both in the short-run and long-run. Both the agriculture and manufacturing sectors are negatively affected by presence of an undervalued exchange rate both in the short-run and long-run periods. These results are consistent with those observed by Masunda (2011). There, undervaluation was confirmed to have a deleterious effect on manufacturing and agriculture sector.

In the short-run, undervaluation is estimated to have a more deleterious effect on the agriculture sector relative to the manufacturing sector. A 10 percent increase in currency undervaluation translates into a 5.9 percent decrease in agricultural output in the short-run. This finding is at odds with that documented in Cho et al. (2001), Rodrik (2008) and Masunda (2011) where the agriculture sector is found to contract in response to currency undervaluation. This negative correlation can be taken to reflect presence of severe trade restrictions that many convert many agricultural commodities into non-tradables at the margin (Rodrik, 2008). Also, one can argue that undervaluation dampens growth in the agriculture sector due to low elasticities of agricultural products to changing prices.

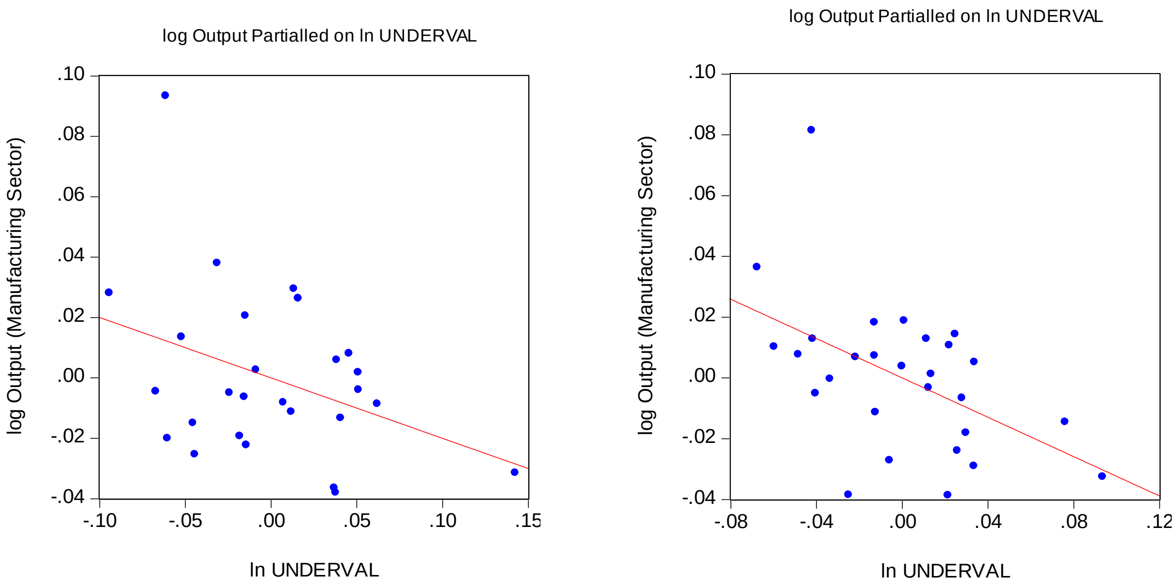


Short-run **Long-run**

The variable on the vertical axis is output in natural logarithm for the period 1985 – 2014 controlling for labour and capital stock in the agriculture sector. The variable on the horizontal axis is the natural logarithm of Rodrik's (2008) measure of undervaluation. Each data point in the scatter represents the partial correlation between undervaluation and output.

Figure 11.1: Conditional Correlation; Agriculture Sector

With respect to the manufacturing sector the effect of undervaluation is much more negative in the long-run compared to the short-run. This is surprising considering that manufacturing is considered highly tradable and that most studies point to a positive effect of undervaluation on overall growth that occurs via expansion of the manufacturing sector.



Short-run **Long-run**

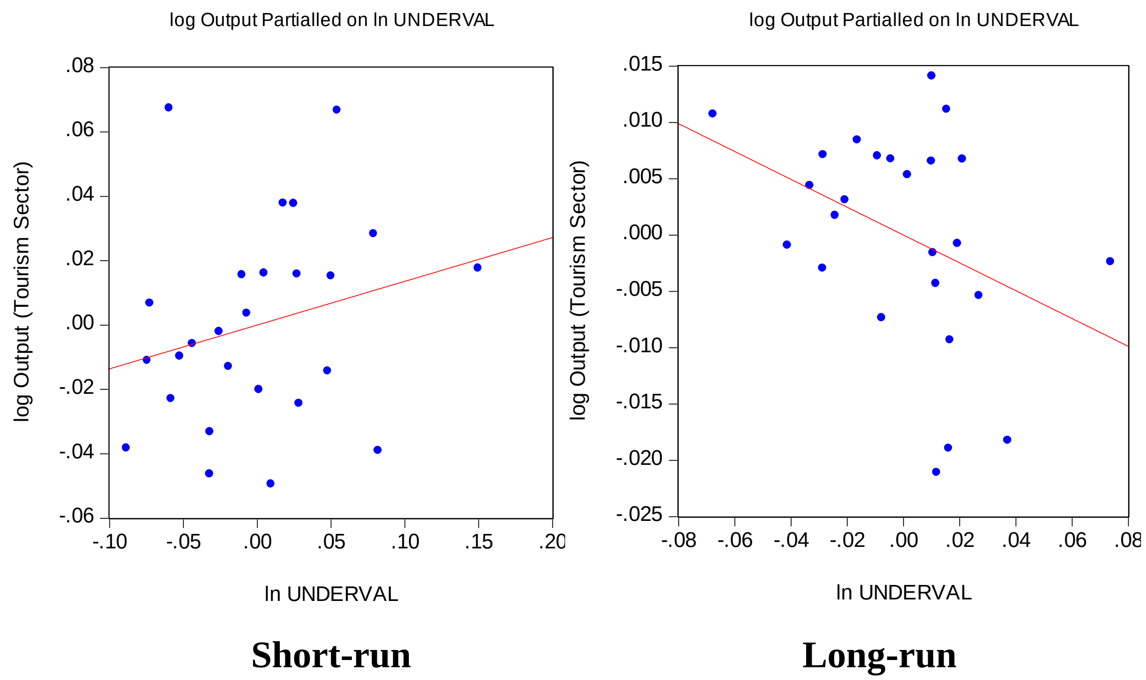
The variable on the vertical axis is output in natural logarithm for the period 1985 – 2014 controlling for labour and capital stock in the agriculture sector. The variable on the horizontal axis is the natural logarithm of Rodrik's (2008) measure of undervaluation. Each data point in the scatter represents the partial correlation between undervaluation and output.

Figure 11.2: Conditional Correlation; Manufacturing Sector

Most of the studies that support a positive correlation between undervaluation and manufacturing growth, including Rodrik (2008), suggest that undervaluation promotes growth by facilitating a reallocation of labour from rural agriculture to the manufacturing sector. This channel is less likely in the South African context for two reasons. The first is that wages are relatively high in South Africa due to the presence of trade unions and this makes it more costly for the manufacturing sector to absorb more labour on the back of currency undervaluation. Secondly, the presence of undervaluation has been matched by a reallocation of labour into tertiary sector rather than the manufacturing sector (Rodrik, 2012), an explanation which could justify the positive correlation between undervaluation and growth in the financial sector in the short-run as documented in table 9.2 above.

Tourism, the financial and the community and personal service sectors seem to benefit from currency undervaluation only in the short-run. In the long-run, these sectors are negatively affected by currency undervaluation with the financial sector being the worst affected sector followed by the community and personal service sector and lastly tourism.

The economic implication of the results is that undervaluing the local currency by 10 percent in the short-run leads to an 8.24 percent expansion of the tourism sector in terms of output. This positive, sizeable and highly significant correlation is plausible taking into account that a depreciated local currency, if the country is worth a visit, makes tourists to stay longer while spending less, which leads to growth of the sector. In the long-run however the negative effect of currency undervaluation on tourism may result from the spillover effects from other sectors that are negatively affected by undervaluation in the long-run.

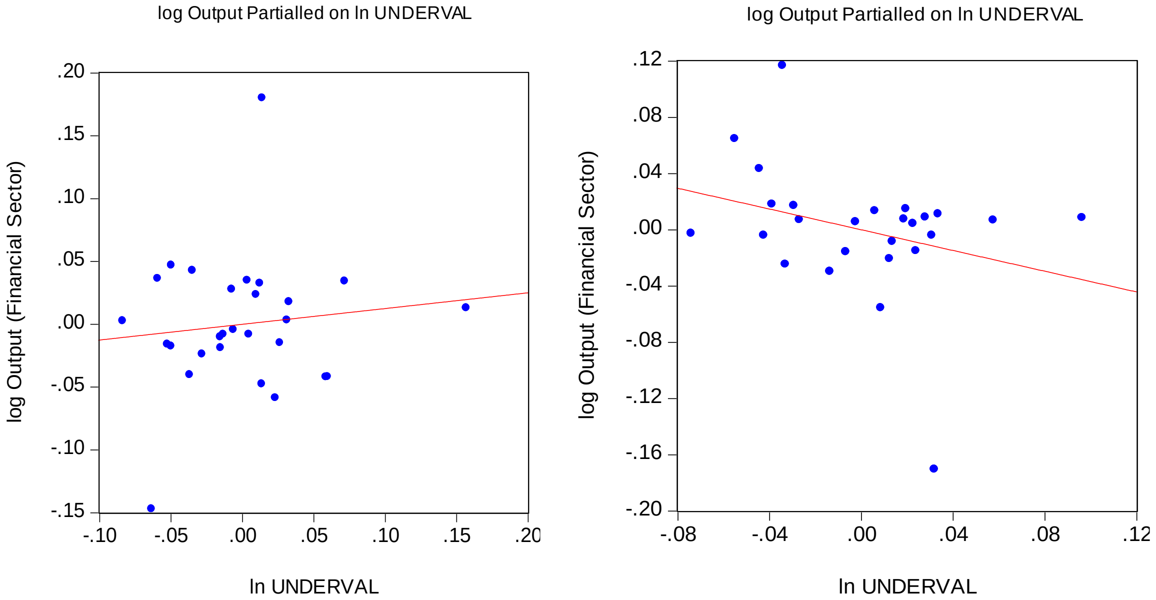


The variable on the vertical axis is output in natural logarithm for the period 1985 – 2014 controlling for labour and capital stock in the agriculture sector. The variable on the horizontal axis is the natural logarithm of Rodrik’s (2008) measure of undervaluation. Each data point in the scatter represents the partial correlation between undervaluation and output.

Figure 12.1: Conditional Correlation; Tourism Sector

With respect to the financial sector, a 10 percent increase in undervaluation is estimated to raise growth by 8.15 percent in the short -run and the effect is statistically significant at the 5 percent level. In support of this empirical finding, one could argue that undervaluation is inflationary and assuming the Mundell-Tobin effect holds, an inflationary environment facilitates the conversion of money holdings into financial assets which consequently drives down interest rates and promotes financial investment leading to growth of the financial sector. In the long-run however, undervaluation has profound dampening effects on growth of the financial sector. A 10 percent increase in undervaluation is estimated to reduce growth by 26 percent which is worrisome given the significant contribution of the financial sector towards GDP in South Africa. The contribution of financial sector towards GDP in South Africa jumped from 17 percent in 1993 to 24 percent in 2012 (StatsSA, 2014).

Within this bag of mixed results, the negative and sizeable effect of undervaluation on financial sector growth conforms to the argument that currency depreciation increases the possibility of financial crisis in the economy particularly in a developing country context where borrowing is generally expressed in foreign currency(Chang and Velasco, 2000). In the long run, this currency crisis is more likely to transform into a banking crisis due to the negative effect on the balance sheets and this leads to contraction of activity in the financial sector.

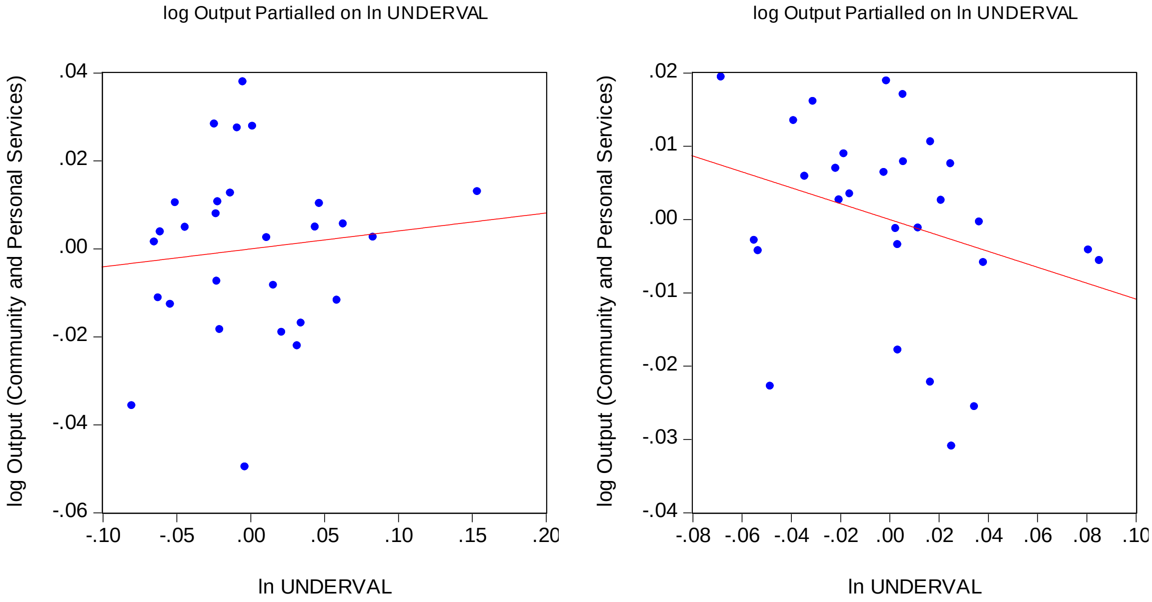


Short-run **Long-run**

The variable on the vertical axis is output in natural logarithm for the period 1985 – 2014 controlling for labour and capital stock in the agriculture sector. The variable on the horizontal axis is the natural logarithm of Rodrik's (2008) measure of undervaluation. Each data point in the scatter represents the partial correlation between undervaluation and output.

Figure 12.2: Conditional Correlation; Financial Sector

Another sector which correlates positively with undervaluation in the short-run but correlates negatively in the long-run is the personal services sector. A possible explanation for this positive short-run correlation is that undervaluation creates an environment that is conducive to growth. It is plausible to expect community and personal services to grow in the short-run in an environment where the overall economy is rising on the back of an undervalued exchange rate. Undervaluation has expenditure switching effects. If the local currency is undervalued, consumption is witched from foreign towards domestically produced goods and services leading to growth of personal services. Figure 12.2 shows the partial effect of undervaluation on growth of the personal services sector in the short-run and long run.



Short-run **Long-run**

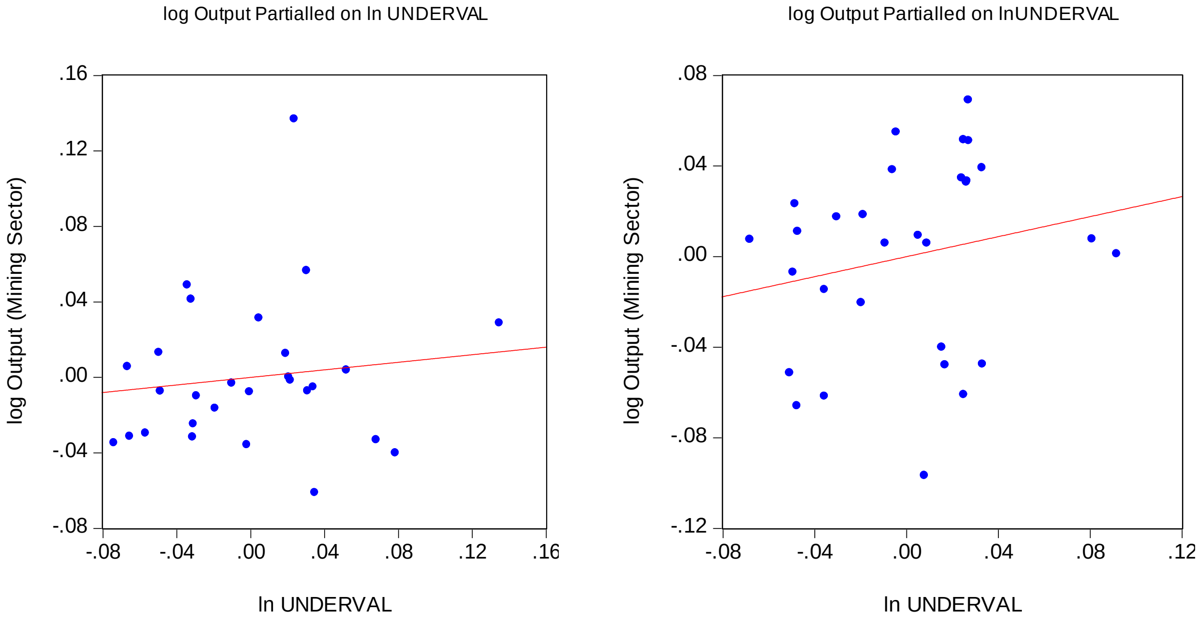
The variable on the vertical axis is output in natural logarithm for the period 1985 – 2014 controlling for labour and capital stock in the agriculture sector. The variable on the horizontal axis is the natural logarithm of Rodrik's (2008) measure of undervaluation. Each data point in the scatter represents the partial correlation between undervaluation and output.

Figure 13.1: Conditional Correlation; Personal Service Sector

In figure 13.1, it can be seen that output in the personal service sector increases with undervaluation while the opposite correlation is true in the long-run. Until now, a common finding emerging from all sectors except agriculture and manufacturing is a positive short-run boost of undervaluation on output and a negative correlation in the long-run.

At the outset, evidence suggests that undervaluation promotes mining activities both in the short-run and long-run. This appears to be the first empirical analysis to demonstrate a positive short-run and long-run impact of undervaluation on output in the mining sector. When Rodrik (2008) documents a positive association between undervaluation and growth of the tradable sector, he specifically refers to the manufacturing sector and not the mining sector.

Our result suggests that neither the agriculture nor the manufacturing sector seems to be the channel via which undervaluation promotes growth in South Africa. Rather, the mining sector appears to be the channel through which the pay-off of undervaluation can be observed as far as South Africa's overall growth is concerned. In response to every 10 percent increase in undervaluation, growth in the mining sector is estimated to jump by 2.84 and 10.68 percent in the short-run and long-run respectively. Thus one can easily observe from these estimates that the effect of undervaluation is much more positive in the long-run than in the short-run. Figure 13.2 corresponds to the partial effect of undervaluation on short-run and long-run output in the mining sector.



Short-run **Long-run**

The variable on the vertical axis is output in natural logarithm for the period 1985 – 2014 controlling for labour and capital stock in the agriculture sector. The variable on the horizontal axis is the natural logarithm of Rodrik's (2008) measure of undervaluation. Each data point in the scatter represents the partial correlation between undervaluation and output.

Figure 13.2: Conditional Correlation; Mining Sector

A visual analysis of figure 13.2 reveals a positive correlation between undervaluation and growth in the mining sector. Small undervaluations coincide with low levels of growth while the large undervaluations are associated with high growth. The line is much steeper in the long-run and flatter in the short-run. This implies that the partial correlation between undervaluation and growth in the mining sector is much more positive in the long-run period as compared to the short-run period. At the time of writing, we am unware of any other study that has demonstrated a positive and long-run co-movement between undervaluation and growth in the mining sector. Figure 14.1 is an attempt to show as explicitly as possible the central result of the study. In terms of construction, this figure traces the growth trend taken by the mining and manufacturing sector following an initial 24 percent depreciation (of Rodrik's (2008) Balassa-

Samuelson adjusted measure) that shows up from the data in 2001. Cutting the data this way raiases the obvious objection of selection bias (in terms of the period) but the virtue is that it allows us to draw important lessons and inferences from the most telling episodes of the sampling period. Visually, growth in the manufacturing sector seems to be held back by undervaluation in subsequent periods while growth of the mining sector rises in the immediate aftermath of currency undervaluation. For illustration purposes, M1 and M2 represent the one year gradient of growth in the mining sector while MG1 and MG2 denote the one year growth gradient for the manufacturing sector. It is clear that the 24 percent undervaluation in 2001 was accompanied by a huge boost in mining activities while the manufacturing sector witnessed a huge slump.

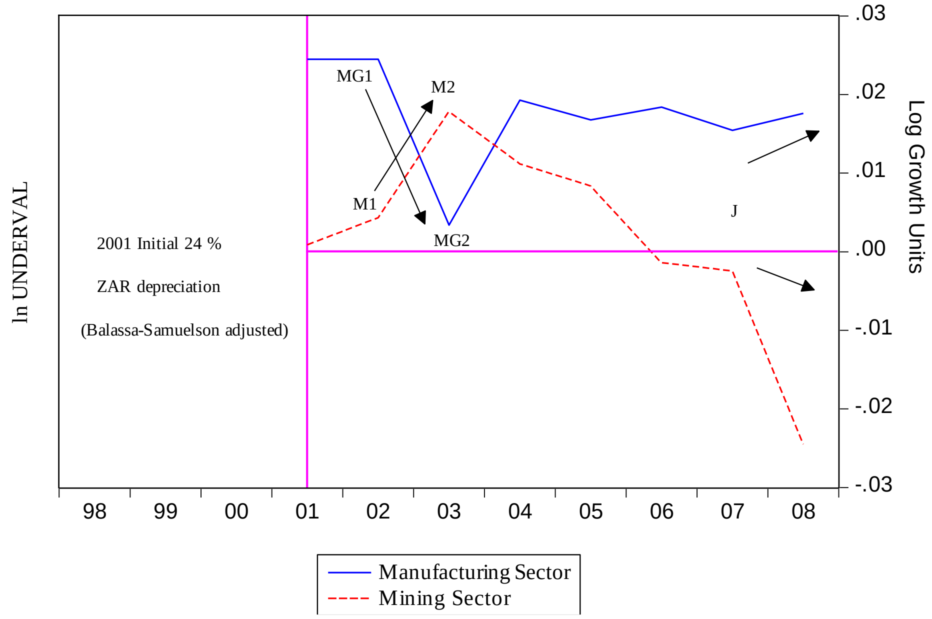


Figure 14.1: Growth in Mining and Manufacturing Sectors

It is important to recall at this point that the results from the interaction term between capital and sectoral growth yielded a positive, sizeable and statistically significant relationship while that of labour and sectoral growth was statistically insignificant. This result can help us further understand the reason why undervaluation seems to promote (dampen) growth in the mining (manufacturing) sectors respectively. The positive undervaluation-capital interaction suggests that the positive effect of undervaluation increases with capital accumulation. The mining sector is capital intensive while the manufacturing sector is generally labour intensive.

5.5 Chapter Summary

The chapter has presented, interpreted and discussed the empirical findings of the study. Entry sections presented summary statistics and diagnostic tests of panel data estimation strategies. Thereafter, results from the baseline estimator, the system GMM and alternative approaches, the fixed effects, random effects and the pooled least squares were presented and discussed. For robustness purposes, results from panel time series evidence and time series approaches were later reported complemented by time series plots of the variables of interest. The main result is that undervaluation raises growth of the mining sector and dampens growth prospects of all other sectors in the long-run. The following section summarises the entire study, concludes and provides policy implications of the findings.

CHAPTER 6

CONCLUSION AND POLICY IMPLICATIONS

The previous chapter presented, interpreted and discussed the empirical findings of the study. This chapter provides a summary of the entire study and gives policy implications based on the central findings of the study. In this regard, the chapter is made up of three main sections. Section 6.1 summarises the entire study. From the previous five outlined chapters, it summarises the contents of each chapter. Thereafter, section 6.2 will conclude and give policy implications based on the major findings of the study. Section 6.3 then suggests areas for further research.

6.1 Summary

The exchange rate policy remains at the heart of international policy discussions and following Rodrik (2008), this study attempted to empirically assess the effects of real exchange rate misalignment particularly undervaluation on sectoral growth while controlling for endogeneity for the period 1985 to 2014. The sectors included in the sample are agriculture, mining, manufacturing, financial, tourism and personal services at the 2 digit level ISIC. The analysis carefully selected from the theoretical literature, sector specific variables that affect the steady state growth of sectors with undervaluation added as an additional variable that affects sectoral growth. Sector specific variables were labour and capital measured as employment and gross capital formation in each sector respectively. Two measures of real exchange rate undervaluation were employed. The first is the Balassa-Samuelson adjusted proposed by Rodrik (2008) which regresses the real exchange rate on income per capita and defines undervaluation as the deviation of the actual real exchange rate from this adjusted rate. The second measure is derived from the model-based approach which defines undervaluation as when the prevailing the real exchange rate is below the equilibrium real exchange rate.

Within the framework of conditional convergence theory, the measures of undervaluation were each then treated in turn as a regressors to appreciate how they relate to sectoral growth. In a panel data setup, the Blundell and Bond system GMM estimation technique were employed to address endogeneity of undervaluation as well as the Nickell-Bias while initial values of the regressors are used to pin down causal issues. Potential variable non-stationarity in panel data was dealt with by the transformation of variables into 5 year averages to remove cyclical effects. In order to understand how real exchange rate undervaluation affects growth of particular sectors, time series techniques were also employed and the model was estimated using the bounds testing procedure suggested by Pesaran and Shin (2001). A careful attention was paid on the data generating process particularly stationarity tests to establish the order of integration and presence of a long-run relationship. The breakpoint unit root tests were used to accommodate potential structural breaks in data and the results suggested a mixture of variable integration, an outcome which necessitated the use of the bounds testing procedure. Given the presence of a long-run relationship among the lagged level variables, both short-run and long-run regression models were estimated.

Overall, the study confirms the following findings: 1) In the short-run period, undervaluation promotes growth in the tourism, financial, mining and personal services sectors, 2) agriculture and manufacturing are all hampered by undervaluation both in the short-run and long-run 3) only the mining sector appears to benefit from undervaluation in both short-run and long-run periods. The latter result could be reflective of immense global competition that turn South Africa's agriculture and manufacturing exports into non-tradables at the margin. There is also a possibility that agriculture and manufacturing sectors do not fully benefit from undervaluation due to exportation of low valued commodities. Another perspective of this result is that undervaluation is hurting agriculture and manufacturing sectors by way of raising the cost of imported intermediate raw materials. On the other hand, the mining sector appears to be the only sector that benefits from undervaluation. A possible explanation behind this result is that South Africa's minerals generally have an already high global demand and undervaluation can significantly boost short-run and long-run growth of the sector. If the domestic currency is undervalued, then local miners can export more minerals on the global market since they will be cheaper in relation to other countries where the currency is relatively overvalued. This result is in line with the argument that once the exchange rate becomes undervalued, it becomes easy to sell in the foreign market. Moving on other sector specific variables, the study found positive effects of conventional factors of production labour and capital on sectoral growth. This is in line with previous studies such as Karadam (2014), Udah et al. (2015) and Masunda (2011) who all confirmed a positive relationship between labour, capital and sectoral growth.

6.2 Conclusions and Policy Implications

The overall conclusion that can be gleaned from this empirical effort is that the effects of undervaluation on economic growth are heterogeneous across sectors both in the short-run and long-run. This conclusion raises a warning over sector aggregation with respect to undervaluation effects. This is not surprising given that the impact of exchange rate undervaluation is largely dependent on the degree of sector tradability.

The conclusion also offers a new insight on the empirical link between undervaluation and growth and raises scepticism about earlier related work that assumes sector homogeneity. Another important conclusion from the study is that undervaluing the local currency hurts most sectors in the long-run in South Africa but encourages both short-run and long-run growth of the mining sector. This raises the obvious question: why hasn't the mining sector driven growth as a channel of exchange rate undervaluation in South Africa?

There are two possibilities of how our estimates could accommodate this empirical reality. The first may be that the mining sector is curtailed by its small size, contributing about 5 percent to GDP. Since exchange rate undervaluation has positive long-run effects on mining and negative effects on manufacturing, financial, tourism and agriculture in the long-run, one can safely conclude that exchange rate undervaluation has a negative overall effect on economic growth by hurting sectors that have a key contribution towards GDP.

The second possibility is that given the presence of nonlinearities in the way undervaluation correlates with sectoral growth, it might be so that the level of undervaluation witnessed for most parts of the sampling period has exceeded the threshold value to the extent that undervaluation has been hurting growth of the mining sector instead. This later possibility is quite plausible given that the Rand has depreciated by more than 50 percent cumulatively since 2011 if figures from the South African Reserve Bank are to be believed.

Although one cannot precisely point to the more relevant possibility of the two, both of them reflect the likely situation that has been prevailing in South Africa over the years. Recent years have seen a persistent depreciation of the South African rand and this has been accompanied by a slump in economic activity. Overall economic growth has been slowing despite the presence of a weakening currency. One can argue that overall growth has been plummeting owing to the contraction of key sectors. The mining sector alone has been too small to help.

The study has come at a time when the economy of South Africa is experiencing prolonged periods of exchange rate depreciation. The ZAR has generally been weakening against the currencies of major trading partners and this has lately raised the question of how the persistent depreciation of the rand is likely to impact economic growth in the medium to long-term. From the econometric evidence, the main findings indicate that depreciation of the rand has had a positive effect on long-run growth of the mining sector. Other sectors are negatively affected in the long-run by the depreciation of the rand. For policy purposes, the question of whether or not maintaining a depreciated currency works as a long-term growth strategy for South Africa therefore hinges upon the question of whether mining activities alone can be the engine of growth in South Africa.

For policy purposes, undervaluation-led growth through the mining sector does not seem to be sustainable in the long-run for a couple of reasons. Firstly, the mining sector is a natural resource sector which is, of course not constrained by domestic demand as minerals are exportable but has a very limited ability to absorb labour since it is generally capital intensive. This is critical when considering the long-run growth prospects of the entire economy taking into account the prevailing unemployment rate that is hovering above 25 per cent.

Secondly, the mining sector has relatively weak downstream and upstream linkages with other sectors and therefore does not have significant spillover effects to the entire economy. Also, the income that is generated in the mining sector is in most cases in the form of accrues and rents to the government and a relatively small group of investors who are often foreign and a few privileged workers. Viewed this way, mining activities, although they can rapidly benefit from undervaluation and grow in the long-run, come at the cost of skewed income distribution and which is not encouraging given the prevailing income inequality that the government has been trying to solve since the end of the apartheid regime.

There are however cases of countries that have successfully and sustainably managed their natural resource wealth into good long-run use and these include New Zealand and Australia. Their success in resource wealth may not be generalised nevertheless to South Africa since both countries are relatively more developed and more stable in macroeconomic terms relative to South Africa. For South Africa, transforming mineral resources into long-term success would require a whole lot of economic transformation aimed at sustaining continued investments in institutions and human capital. Achieving this transformation is however often blocked by unfavourable political and economic dynamics that are associated with natural resource driven growth.

To achieve economic growth, therefore, there is a need for monetary authorities to engage in monetary policies that prevent currency weakening or that strengthen the rand and this can be achieved through tightening monetary policies particularly raising the interest rate. The downside of tightening the monetary policy is however that high interest rates suppress domestic investment by raising the cost of borrowing. This is particularly worrisome when one takes into account the fact that domestic investment has generally been low over the years owing to a low savings rate. The weaker rand on the other hand has fuelled increased domestic consumption due to expenditure switching effects as domestic consumers demand more domestically produced goods relative to foreign produced goods. Against this background, tightening the monetary policy would be akin to killing two birds with one stone. The first achievement would be the strengthening of the local currency while the second would be the lowering demand pull inflation. The latter is particularly interesting given the prevailing monetary arrangement where the key objective is to contain inflation within the 3 to 6 per cent range.

6.3 Areas for Further Study

The study has examined the empirical link between exchange rate undervaluation and growth in 6 sectors in South Africa at the 2 digit level. The overall results indicate that undervaluation dampens the long-run growth prospects of most sectors with the exception of the mining sector. There is a possibility however that undervaluation may encourage long-run growth of industries within each of the sectors. Put differently, there is a possibility that the effects of undervaluation may not be uniform at industrial level within the sectors. Future studies could therefore benefit from exploring how undervaluation relates to growth of industries at a much higher digit level. Higher digit level data is available at Statistics South Africa. For the manufacturing sector for instance, this would imply focussing on such industries as motor vehicles, rubber, paper and wood while mining would require looking at gold and diamond.

Another area that would be interesting would be to link exchange rate undervaluation with the technical efficiency of either sectors or industries using stochastic frontier models. Empirically, an overvalued exchange rate creates competition in import-competing sectors and from standard economic theory, competition leads to an improvement in both technical and allocative efficiency. One could also expect exchange rate over/under-valuation to have an influence on technical efficiency through its effect on the real wages of workers. This area has not received much attention at the empirical level and future studies can take it further using frontier models. Science is a human endeavour.

REFERENCES

ABIDA, Z. 2011. Real exchange rate misalignment and economic growth: An empirical study for the Maghreb countries. *Zagreb International Review of Economics and Business,* 14**,** 87-105.

AFLOUK, N. & MAZIER, J. 2011. Exchange Rate Misalignments and Economic Growth Non-linear Models Based Study. Working Paper.

AL-RASHIDI, A. & LAHIRI, B. 2013. The effect of exchange rate volatility on trade: correcting for selection bias and asymmetric trade flows. *Applied Economics Letters,* 20**,** 1121-1126.

ANTIN, D. 2013. The South African Mining Sector: An Industry at a Crossroads. *Economic Report South Africa*.

ARELLANO, M. & BOND, S. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies,* 58**,** 277-297.

ARELLANO, M. & BOVER, O. 1995. Another look at the instrumental variable estimation of error-components models. *Journal of econometrics,* 68**,** 29-51.

BAFFES, J., ELBADAWI, I. A. & O'CONNELL, S. A. 1997. *Single-equation estimation of the equilibrium real exchange rate,* World Bank, Development Research Group.

BAI, J. & NG, S. 2004. A PANIC attack on unit roots and cointegration. *Econometrica,* 72**,** 1127-1177.

BALTAGI, B. H. & KAO, C. 2000. Nonstationary panels, cointegration in panels and dynamic panels: A survey. *Syracuse University Center for Policy Research Working Paper*.

BANK, S. A. R. 2015. *South African Reserve Bank Quarterly Bulletin*.

BARRO, R. 1995. Inflation and Economic Growth. *NBER Working Paper* No 5326.

BAUM, A., POPLAWSKI-RIBEIRO, M. & WEBER, A. 2012. Fiscal Multipliers and the State of the Economy.

BÉREAU, S., VILLAVICENCIO, A. L. & MIGNON, V. 2010. Nonlinear adjustment of the real exchange rate towards its equilibrium value: A panel smooth transition error correction modelling. *Economic Modelling,* 27**,** 404-416.

BÉREAU, S., VILLAVICENCIO, A. L. & MIGNON, V. 2012. Currency misalignments and growth: a new look using nonlinear panel data methods. *Applied Economics,* 44**,** 3503-3511.

BERG, A. & MIAO, Y. 2010. The real exchange rate and growth revisited: The Washington Consensus strikes back? *IMF Working Papers***,** 1-24.

BERGMAN, M. 2006. Sectoral real exchange rate adjustments in Europe. *Manuscript available at http://www. econ. ku. dk/okombe/# wp*.

BERKA, M., DEVEREUX, M. B. & ENGEL, C. 2014. Real exchange rates and sectoral productivity in the eurozone. National Bureau of Economic Research.

BERNANKE, B. S. 2005. The global saving glut and the US current account deficit.

BHATTACHARYA, A., MONTIEL, P. & SHARMA, S. 1997. Private capital flows to sub-Saharan Africa: An overview of trends and determinants. *External Finance for Low-Income Countries***,** 207-232.

BHORAT, H., TIAN, N. & ELLYNE, M. 2014. The Real Exchange Rate and Sectoral Employment in South Africa.

BINDER, M., HSIAO, C. & PESARAN, M. H. 2005. Estimation and inference in short panel vector autoregressions with unit roots and cointegration. *Econometric Theory*, 21**,** 795-837.

BIROL, Ö. H. 2015. What It Means to be a New Classical Economist. *Procedia - Social and Behavioral Sciences*, 195**,** 574-579.

BITTENCOURT, M., VAN EYDEN, R. & SELETENG, M. 2014. Inflation and Economic Growth: Evidence from the Southern African Development Countries.

BLUNDELL, R. & BOND, S. 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, 87**,** 115-143.

BRANSON, W. H. & LOVE, J. P. 1987. The real exchange rate and employment in US manufacturing: State and regional results. National Bureau of Economic Research Cambridge, Mass., USA.

BREITUNG, J. & DAS, S. 2005. Panel unit root tests under cross-sectional dependence. *Statistica Neerlandica*, 59**,** 414-433.

BRIXIOVÁ, Z. & NCUBE, M. 2014. The Real Exchange Rate and Growth in Zimbabwe: Does the Currency Regime Matter?

CAMERON, A. C. & TRIVEDI, P. K. 2005. *Microeconometrics: methods and applications*, Cambridge university press.

CHANG, R. & VELASCO, A. 2000. Liquidity crises in emerging markets: theory and policy. *NBER Macroeconomics Annual 1999, Volume 14.* MIT.

CHEN, R. & DAO, M. 2011. The real exchange rate and employment in China. *IMF Working Papers*, 1-50.

CHIANG, M.-H. & KAO, C. 2002. Nonstationary panel time series using NPT 1.3–A user guide. *Center for Policy Research, Syracuse University*.

CHOI, I. 2001. Unit root tests for panel data. *Journal of international money and Finance,* 20**,** 249-272.

CHUDIK, A. & PESARAN, M. H. 2015. Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics,* 188**,** 393-420.

COUHARDE, C. & SALLENAVE, A. 2013. How do currency misalignments' threshold affect economic growth? *Journal of Macroeconomics,* 36**,** 106-120.

DE GREGORIO, J., GIOVANNINI, A. & WOLF, H. C. 1994. International evidence on tradables and nontradables inflation. *European Economic Review,* 38**,** 1225-1244.

DE JAGER, S. 2012. Working Paper-WP/12/02-Modelling South Africaâ€™ s equilibrium real effective exchange rate-A VECM approach.

DI NINO, V., EICHENGREEN, B. & SBRACIA, M. 2011. Real Exchange Rates, Trade, and Growth: Italy 1861-2011. *Bank of Italy Economic History Working Paper*.

DUBAS, J. 2012. Exchange Rate Misalignment and Economic Growth.

DUBAS, J. M. 2009. The importance of the exchange rate regime in limiting misalignment. *World Development*, 37**,** 1612-1622.

EBAIDALLA, E. M. 2014. Real exchange rate misalignment and economic performance in Sudan. *African Review of Economics and Finance,* 6**,** 115-140.

EBERHARDT, M. & TEAL, F. 2010. *Productivity analysis in global manufacturing production*, Department of Economics, University of Oxford.

EDWARDS, S. 1988. Real and monetary determinants of real exchange rate behavior: Theory and evidence from developing countries. *Journal of development economics,* 29**,** 311-341.

ELBADAWI, I. A., KALTANI, L. & SOTO, R. 2012. Aid, real exchange rate misalignment, and economic growth in Sub-Saharan Africa. *World Development,* 40**,** 681-700.

ENU, P., HAGAN, E. & ATTAH-OBENG, P. 2013. IMPACT OF MACROECONOMIC FACTORS ON INDUSTRIAL PRODUCTION IN GHANA. *European Scientific Journal,* 9.

EUN, C., KıLıÇ, R. & LAI, S. 2012. A Tale of Two Exchange Rates: South Africa's Dual-Rate Experiment. *Available at SSRN 2020124*.

EVERAERT, G. & DE GROOTE, T. 2016. Common correlated effects estimation of dynamic panels with cross-sectional dependence. *Econometric Reviews,* 35**,** 428-463.

GALA, P. 2008. Real exchange rate levels and economic development: theoretical analysis and econometric evidence. *Cambridge Journal of economics,* 32**,** 273-288.

GEHRINGER, A. 2013. Another look at the determinants of current account imbalances in the European Union: An empirical assessment. FIW.

GHURA, D. & GRENNES, T. J. 1993. The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of Development Economics,* 42**,** 155-174.

GILES, J. & WILLIAMS, C. L. 2000. Export-led growth: a survey of the empirical literature and some non-causality results. Part 1. *The Journal of International Trade & Economic Development,* 9**,** 261-337.

GLÜZMANN, P. A., LEVY-YEYATI, E. & STURZENEGGER, F. 2012. Exchange rate undervaluation and economic growth: Díaz Alejandro (1965) revisited. *Economics Letters,* 117**,** 666-672.

GUJARATI, D. 2014. *Econometrics by example,* Palgrave Macmillan.

GUO, K. & N'DIAYE, P. 2009. Employment effects of growth rebalancing in China. *IMF Working Papers***,** 1-16.

HADRI, K. 2000. Testing for stationarity in heterogeneous panel data. *The Econometrics Journal,* 3**,** 148-161.

HAMEL, G. 1991. Competition for competence and interpartner learning within international strategic alliances. *Strategic management journal,* 12**,** 83-103.

HARRIS, R. & SOLLIS, R. 2003. *Applied time series modelling and forecasting*, Wiley.

HARRIS, R. D. & TZAVALIS, E. 1999. Inference for unit roots in dynamic panels where the time dimension is fixed. *Journal of econometrics,* 91**,** 201-226.

IM, K. S., PESARAN, M. H. & SHIN, Y. 2003. Testing for unit roots in heterogeneous panels. *Journal of econometrics,* 115**,** 53-74.

IYKE, B. N. & ODHIAMBO, N. M. 2015. REAL EXCHANGE MISALIGNMENTS AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICA: PANEL DATA EVIDENCE.

KANDIL, M. & MIRZAIE, A. 2002. Exchange rate fluctuations and disaggregated economic activity in the US: theory and evidence. *Journal of International Money and Finance,* 21**,** 1-31.

KAO, C. 1999. Spurious regression and residual-based tests for cointegration in panel data. *Journal of econometrics,* 90**,** 1-44.

KAO, C. & CHIANG, M.-H. 1999. On the estimation and inference of a cointegrated regression in panel data. *Available at SSRN 1807931*.

KARADAM, D. Y. 2014. *THE REAL EXCHANGE RATE and ECONOMIC GROWTH.* MIDDLE EAST TECHNICAL UNIVERSITY.

KARORO, T. D., AZIAKPONO, M. J. & CATTANEO, N. 2009. EXCHANGE RATE PASS-THROUGH TO IMPORT PRICES IN SOUTH AFRICA: IS THERE ASYMMETRY? 1. *South African Journal of Economics,* 77**,** 380-398.

LEVIN, A. & LIN, C.-F. 1993. Unit root tests in panel data: new results. *University of California at San Diego, Economics Working Paper Series*.

LEVY-YEYATI, E. & STURZENEGGER, F. 2003. To float or to fix: evidence on the impact of exchange rate regimes on growth. *The American Economic Review,* 93**,** 1173-1193.

LEVY-YEYATI, E., STURZENEGGER, F. & GLUZMANN, P. A. 2013. Fear of appreciation. *Journal of Development Economics,* 101**,** 233-247.

LUCAS, R. J. 1988. On the mechanics of economic development. *Journal of Monetary Economics,* 22**,** 3-42.

MADDALA, G. S. & WU, S. 1999. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics,* 61**,** 631-652.

MASUNDA, S. 2011. Real exchange rate misalignment and sectoral output in Zimbabwe. *International Journal of Research and Economics,* 2**,** 59-74.

MASUNDA, S. 2012. Real exchange rate misalignment and currency crisis in Zimbabwe. *Journal of Emerging Trends in Economics and Management Sciences,* 3**,** 923.

MAZORODZE, B. T. 2014. Real Exchange Rate Misalignment and Agricultural Trade; a Panel Analysis. *ir.msu.ac.zw:8080/xmlui/handle/11408/726*.

MBAYE, S. 2012. Real Exchange Rate Undervaluation and Growth: Is there a Total Factor Productivity Growth Channel?

MOON, H., PERRON, B. & PHILLIPS, P. 2006. On the Breitung test for panel unit roots and local asymptotic power. *Econometric Theory,* 22**,** 1179-1190.

MPOFU, T. R. Real Exchange Rate Volatility and Employment Growth in South Africa: The Case of Manufacturing! ECCE-USB conference, 2013.

NGANDU, S. 2008. Exchange rates and employment. *South African Journal of Economics,* 76**,** S205-S221.

NICKELL, S. 1981. Biases in dynamic models with fixed effects. *Econometrica: Journal of the Econometric Society*, 1417-1426.

NJINDAN, I. B. 2016. Exchange Rate Undervaluation and Sectoral Performance of the South African Economy.

ÖZYURT, S. 2013. Currency Undervaluation and Economic Rebalancing towards Services: Is China an Exception? *China & World Economy,* 21, 47-63.

PEDRONI, P. 2001. Purchasing power parity tests in cointegrated panels. *Review of Economics and Statistics,* 83, 727-731.

PERRON, P. 1994. Trend, unit root and structural change in macroeconomic time series. Escola de Pós-Graduação em Economia da FGV.

PERSYN, D. & WESTERLUND, J. 2008. Error-correction-based cointegration tests for panel data. *Stata Journal,* 8, 232-241.

PESARAN, M. H. 2006. Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica,* 74, 967-1012.

PESARAN, M. H. 2007. A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22, 265-312.

PESARAN, M. H. 2015. Testing weak cross-sectional dependence in large panels. *Econometric Reviews,* 34, 1089-1117.

PESARAN, M. H., SHIN, Y. & SMITH, R. J. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, 16, 289-326.

PESARAN, M. H., SHIN, Y. & SMITH, R. P. 1999. Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association,* 94, 621-634.

PHILLIPS, P. C. & MOON, H. R. 1999. Linear regression limit theory for nonstationary panel data. *Econometrica,* 67, 1057-1111.

RAMAILA, M., MAHLANGU, S. & DU TOIT, D. 2011. Agricultural productivity in South Africa: literature review. South Africa: Directorate: Economics services production economics unit.

REINHART, C. M. & ROGOFF, K. S. 2002. The modern history of exchange rate arrangements: a reinterpretation. national bureau of economic Research.

REVENGA, A. L. 1992. Exporting jobs?: The impact of import competition on employment and wages in US manufacturing. *The Quarterly Journal of Economics*, 255-284.

RODRIK, D. 2008. The real exchange rate and economic growth. *Brookings papers on economic activity,* 2008, 365-412.

RODRIK, D. 2014. An African growth miracle? : National Bureau of Economic Research.

ROMER, P. 1986. Increasing returns and long-run growth. *Journal of Political Economy,* 94**,** 1002-1037.

SAAYMAN, A. 2010. A panel data approach to the behavioural equilibrium exchange rate of the ZAR. *South African journal of economics,* 78**,** 57-75.

SALLENAVE, A. 2010. Real exchange rate misalignments and economic performance for the G20 countries. *Economie internationale***,** 59-80.

SAPIR, A. & SEKKAT, K. 1995. Exchange rate regimes and trade prices Does the EMS matter? *Journal of International Economics,* 38**,** 75-94.

SARB 2015. Quarterly Bulletin. Pretoria: SARB.

SARB 2016. Monetary Policy Review October. South Africa: Reserve Bank of South Africa.

SIBANDA, K., NCWADI, R. & MLAMBO, C. 2013. Investigating the Impacts of Real Exchange Rates on Economic Growth: A Case study of South Africa. *Mediterranean Journal of Social Sciences,* 4**,** 261.

SIMON-OKE, O. & ARIBISALA, S. 2010. Exchange Rate Deregulation and Industrial Performance: An Assessment (1975–2006). *African Research Review,* 4.

SKOTT, P., RAPETTI, M. & RAZMI, A. 2012. Real exchange rates and the long-run effects of aggregate demand in economies with underemployment.

SOLOW, R. M. 1956. A contribution to the theory of economic growth. *The quarterly journal of economics***,** 65-94.

STATSSA 2014. Quarterly Employment Statistics. South Africa: Statistics South Africa.

STOCK, J. H. & WATSON, M. W. 1993. A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica: Journal of the Econometric Society***,** 783-820.

SWAN, T. W. 1956. Economic growth and capital accumulation. *Economic record,* 32**,** 334-361.

TOULABOE, D. 2006. Real exchange rate misalignment and economic growth in developing countries. *Southwestern Economic Review,* 33**,** 57-74.

UDAH, S., NWACHUKWU, I. & AKPAN, S. 2015. Performance Evaluation of Various Policy Regimes Toward Agricultural Growth in Nigeria. *International Journal of Agriculture, Forestry and Fisheries,* 3**,** 57.

VAN BON, N. 2014. Current Account and Fiscal Deficits Evidence of Twin Divergence from Selected Developing Economies of Asia. *Southeast Asian Journal of Economics,* 2.

VAN DER MERWE, E. 1996. *Exchange rate management policies in South Africa: Recent experience and prospects*, South African Reserve Bank.

VAZ, P. H. & BAER, W. 2014. Real exchange rate and manufacturing growth in Latin America. *Latin American Economic Review,* 23**,** 1-17.

VOGELSANG, T. J. & PERRON, P. 1998. Additional tests for a unit root allowing for a break in the trend function at an unknown time. *International Economic Review***,** 1073-1100.

WESTERLUND, J. 2007. Testing for error correction in panel data. *Oxford Bulletin of Economics and statistics,* 69**,** 709-748.

WOODFORD, M. 2009. Is an undervalued currency the key to economic growth? *Department of Economics discussion paper*.

WOOLDRIDGE, J. M. 2003. Cluster-sample methods in applied econometrics. *The American Economic Review,* 93**,** 133-138.

YAN, H.-D. & YANG, C.-L. 2012. Does an undervalued currency merit economic growth?: Evidence from Taiwan. *Panoeconomicus,* 59**,** 37-57.

ZAKARIA, M. 2010. Exchange Rate Misalignment and Economic Growth: Evidence from Pakistan's Recent Float. *The Singapore Economic Review*, 55**,** 471-489.

ZALK, N. 2014. What is the role of manufacturing in boosting economic growth and employment in South Africa. Econ3x3, viewed.

ZIRAMBA, E. 2013. Measuring exchange market pressure in South Africa: an application of the Girton-Roper monetary model. *South African Journal of Economic and Management Sciences*, 10**,** 89-98.

ZWEDALA, S. 2013. *The effect of real exchange rate misalignment on economic growth in South Africa.* North-West University.

APPENDIX A: BASELINE RESULTS

BLUNDELL AND BOND SYSTEM GMM ONE STEP ESTIMATES

```
System dynamic panel-data estimation          Number of obs         =        30
Group variable: id                            Number of groups      =         6
Time variable: window
                                              Obs per group:    min =         5
                                                                avg =         5
                                                                max =         5

Number of instruments =     36                Wald chi2(5)          =    268.41
                                              Prob > chi2           =    0.0000
One-step results
```

growth	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth						
L1.	.1690062	.1786809	0.95	0.344	-.181202	.5192143
initial	-.0192949	.0090841	-2.12	0.034	-.0370994	-.0014904
lnunderval_5	.1775862	.061837	2.87	0.004	.0563879	.2987844
lnlabour_5	.0291247	.0175174	1.66	0.096	-.0052087	.0634582
lncapital_5	.0417139	.0195313	2.14	0.033	.0034333	.0799946
_cons	-.2932987	.1296726	-2.26	0.024	-.5474523	-.0391451

```
Instruments for differenced equation
        GMM-type: L(2/.).growth L(2/.).initial L(2/.).lnunderval_5
                  L(2/.).lnlabour_5 L(2/.).lncapital_5
Instruments for level equation
        GMM-type: LD.growth LD.initial LD.lnunderval_5 LD.lnlabour_5
                  LD.lncapital_5
        Standard: _cons
```

ARELLANO AND BOND AR (2) TEST

Arellano-Bond test for zero autocorrelation in first-differenced errors

Order	z	Prob > z
1	-1.9952	0.0460
2	-.33898	0.7346

H0: no autocorrelation

SARGAN TEST

```
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(30)      =   24.7573
        Prob > chi2   =    0.7367
```

APPENDIX B: ALTERNATIVE ESTIMATORS

POOLED LEAST SQUARES

Source	SS	df	MS
Model	.005466092	4	.001366523
Residual	.010153096	25	.000406124
Total	.015619188	29	.000538593

Number of obs =	30
F(4, 25) =	3.36
Prob > F =	0.0247
R-squared =	0.3500
Adj R-squared =	0.2460
Root MSE =	.02015

growth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	-.0150275	.0132037	-1.14	0.266	-.0422211	.0121661
lnlabour_5	.0257896	.0124165	2.08	0.048	.0002173	.0513618
lncapital_5	.0322233	.0147217	2.19	0.038	.0019034	.0625431
lnunderval_5	.2015828	.0980088	2.06	0.050	-.0002702	.4034359
_cons	-.2347462	.1060355	-2.21	0.036	-.4531304	-.016362

MODEL SPECIFICATION

```
Ramsey RESET test using powers of the fitted values of growth
       Ho:  model has no omitted variables
                  F(3, 22) =      1.84
                  Prob > F =      0.1688
```

HETEROSCEDASTICITY

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of growth

         chi2(1)      =     1.53
         Prob > chi2  =   0.2160
```

FIXED EFFECTS REGRESSION

```
Fixed-effects (within) regression               Number of obs      =        30
Group variable: id                              Number of groups   =         6

R-sq:  within  = 0.2982                         Obs per group: min =         5
       between = 0.4718                                        avg =       5.0
       overall = 0.3170                                        max =         5

                                                F(4,20)            =      2.12
corr(u_i, Xb)  = -0.6795                        Prob > F           =    0.1154

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     initial |  -.0164014   .0508302    -0.32   0.750    -.1224314    .0896286
  lnlabour_5 |    .046272   .1329066     0.35   0.731    -.2309663    .3235102
 lncapital_5 |   .0649433   .0400477     1.62   0.121    -.0185947    .1484813
lnunderval_5 |   .2083979    .093191     2.24   0.037     .0140048     .402791
       _cons |  -.5470663   .6031139    -0.91   0.375     -1.80514    .7110071
-------------+----------------------------------------------------------------
     sigma_u |  .01676622
     sigma_e |  .01855388
         rho |  .44951603   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(5, 20) =     1.90               Prob > F = 0.1396
```

RANDOM EFFECTS REGRESSION

```
Random-effects GLS regression                   Number of obs      =        30
Group variable: id                              Number of groups   =         6

R-sq:  within  = 0.2841                         Obs per group: min =         5
       between = 0.4709                                        avg =       5.0
       overall = 0.3412                                        max =         5

                                                Wald chi2(4)       =     10.66
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0307

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     initial |  -.0124142   .0205758    -0.60   0.546    -.0527421    .0279137
  lnlabour_5 |   .0253637   .0218382     1.16   0.245    -.0174384    .0681658
 lncapital_5 |   .0419861   .0224156     1.87   0.061    -.0019477    .0859199
lnunderval_5 |   .2043182    .086945     2.35   0.019      .033909    .3747273
       _cons |  -.3074388   .1633868    -1.88   0.060     -.627671    .0127934
-------------+----------------------------------------------------------------
     sigma_u |  .01467852
     sigma_e |  .01855388
         rho |  .38495064   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

APPENDIX C: NON-LINEAR EFFECTS

BLUNDELL AND BOND SYSTEM GMM ONE STEP ESTIMATES

```
Group variable: id                              Number of groups      =         6
Time variable: year
                                                Obs per group:    min =        25
                                                                  avg =        25
                                                                  max =        25

Number of instruments =    267                  Wald chi2(5)          =     50.63
                                                Prob > chi2           =    0.0000
One-step results
```

growth	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth						
L1.	-.0492035	.1370207	-0.36	0.720	-.3177591	.2193521
initial	-.008026	.0030242	-2.65	0.008	-.0139533	-.0020986
lnlabour	.0160457	.0043361	3.70	0.000	.0075471	.0245443
lncapital	.0149382	.0060899	2.45	0.014	.0030022	.0268742
lnunderval	.0277279	.0094363	2.94	0.003	.0092331	.0462228
lnunderval_sqr	-.0322953	.0125795	-2.57	0.010	-.0569507	-.00764
_cons	-.1309505	.0449424	-2.91	0.004	-.219036	-.0428649

```
Instruments for differenced equation
        GMM-type: L(2/.).growth L(2/.).initial L(2/.).lnlabour
                  L(2/.).lncapital L(2/.).lnunderval L(2/.).lnunderval_sqr
Instruments for level equation
        GMM-type: LD.growth LD.initial LD.lnlabour LD.lncapital LD.lnunderval
                  LD.lnunderval_sqr
        Standard: _cons
```

ARELLANO AND BOND AR (2) TEST

```
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(260)     =  254.521
        Prob > chi2   =   0.5842
```

SARGAN TEST

Arellano-Bond test for zero autocorrelation in first-differenced errors

Order	z	Prob > z
1	-2.1574	0.0310
2	-.87294	0.3827

H0: no autocorrelation

POOLED LEAST SQUARES

F(5, 144)	= 3.34
Prob > F	= 0.0069
R-squared	= 0.0746
Root MSE	= .02059

growth	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	-.0072199	.0079927	-0.90	0.368	-.0230181	.0085782
lnlabour	.013802	.0052852	2.61	0.010	.0033554	.0242487
lncapital	.0095236	.0056892	1.67	0.096	-.0017215	.0207687
lnunderval	.0272385	.0197651	1.38	0.170	-.0118287	.0663057
lnunderval_sqr	-.0292697	.0148489	-1.97	0.051	-.0586196	.0000803
_cons	-.0914612	.0419392	-2.18	0.031	-.1743572	-.0085652

FIXED EFFECTS REGRESSION

Group variable: id — Number of groups = 6

R-sq: within	= 0.0330	Obs per group: min	= 25
between	= 0.1128	avg	= 25.0
overall	= 0.0283	max	= 25
		F(5,139)	= 0.95
corr(u_i, Xb)	= -0.5581	Prob > F	= 0.4520

growth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	.0115882	.0253798	0.46	0.649	-.0385923	.0617686
lnlabour	.0202962	.0222423	0.91	0.363	-.0236808	.0642732
lncapital	-.0042357	.061434	-0.07	0.945	-.1257016	.1172302
lnunderval	.0225486	.024949	0.90	0.368	-.0267801	.0718773
lnunderval_sqr	-.0400249	.0277149	-1.44	0.151	-.0948221	.0147724
_cons	-.153342	.2752757	-0.56	0.578	-.697611	.3909271
sigma_u	.00807301					
sigma_e	.02050987					
rho	.13414926	(fraction of variance due to u_i)				

RANDOM EFFECTS REGRESSION

```
Group variable: id                              Number of groups   =         6

R-sq:  within  = 0.0286                         Obs per group: min =        25
       between = 0.5754                                        avg =      25.0
       overall = 0.0739                                        max =        25

                                                Wald chi2(5)       =      7.07
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.2152

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     initial |  -.0056351   .0093012    -0.61   0.545    -.0238651    .0125949
    lnlabour |   .0148404   .0093599     1.59   0.113    -.0035047    .0331854
   lncapital |    .008865   .0089229     0.99   0.320    -.0086236    .0263537
  lnunderval |   .0267345   .0211187     1.27   0.206    -.0146575    .0681265
lnunderval_sqr | -.0303516  .0201569    -1.51   0.132    -.0698584    .0091553
       _cons |  -.1025241   .0667198    -1.54   0.124    -.2332926    .0282444
-------------+----------------------------------------------------------------
     sigma_u |  .00520689
     sigma_e |  .02050987
         rho |  .06054878   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

APPENDIX D: INTERACTION TERMS

BLUNDELL AND BOND SYSTEM GMM ONE STEP ESTIMATES

```
System dynamic panel-data estimation          Number of obs        =        30
Group variable: id                            Number of groups     =         6
Time variable: window
                                              Obs per group:   min =         5
                                                               avg =         5
                                                               max =         5

Number of instruments =     39                Wald chi2(5)         =    224.53
                                              Prob > chi2          =    0.0000
One-step results
```

growth	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth L1.	.2511466	.1385744	1.81	0.070	-.0204542	.5227475
initial	-.0207969	.0066457	-3.13	0.002	-.0338222	-.0077716
lnunderval_5	-3.407024	1.511896	-2.25	0.024	-6.370285	-.4437625
lncapital_5	.0359796	.0154287	2.33	0.020	.00574	.0662192
lnlabour_5	.0222969	.0155418	1.43	0.151	-.0081644	.0527583
lnUNDERVAL_lnlabour	.1344641	.1215316	1.11	0.269	-.1037334	.3726617
lnUNDERVAL_lncapital	.4506451	.2105402	2.14	0.032	.0379939	.8632963
_cons	-.2122781	.094295	-2.25	0.024	-.3970929	-.0274632

```
Instruments for differenced equation
        GMM-type: L(2/.).growth L(2/.).initial L(2/.).lnunderval_5
                  L(2/.).lncapital_5 L(2/.).lnlabour_5 L(2/.).lnUNDERVAL_lnlabour
                  L(2/.).lnUNDERVAL_lncapital
Instruments for level equation
        GMM-type: LD.growth LD.initial LD.lnunderval_5 LD.lncapital_5 LD.lnlabour_5
                  LD.lnUNDERVAL_lnlabour LD.lnUNDERVAL_lncapital
        Standard: _cons
```

ARELLANO AND BOND AR (2) TEST

Arellano-Bond test for zero autocorrelation in first-differenced errors

Order	z	Prob > z
1	-1.9808	0.0476
2	-.87234	0.3830

H0: no autocorrelation

SARGAN TEST

```
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(31)      =  21.16601
        Prob > chi2   =    0.9075
```

BLUNDELL AND BOND SYSTEM GMM ONE STEP ESTIMATES

```
System dynamic panel-data estimation           Number of obs         =        30
Group variable: id                             Number of groups      =         6
Time variable: window
                                               Obs per group:    min =         5
                                                                 avg =         5
                                                                 max =         5

Number of instruments =     39                 Wald chi2(5)          =     53.38
                                               Prob > chi2           =    0.0000
One-step results
```

growth	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth						
L1.	.343616	.1523238	2.26	0.024	.0450668	.6421652
initial	-.0187185	.0065934	-2.84	0.005	-.0316413	-.0057958
lnunderval_5	-3.008631	1.538492	-1.96	0.051	-6.02402	.0067586
lncapital_5	.0278864	.0170621	1.63	0.102	-.0055548	.0613276
lnlabour_5	.0184167	.0130625	1.41	0.159	-.0071852	.0440187
lnUNDERVAL_lnlabour	.3067244	.1059877	2.89	0.004	.0989923	.5144565
lnUNDERVAL_lncapital	.6088823	.1661563	3.66	0.000	.2832219	.9345426
lnUNDERVAL_initial	-.4180431	.2110555	-1.98	0.048	-.8317043	-.004382
_cons	-.1547469	.1003229	-1.54	0.123	-.3513762	.0418824

```
Instruments for differenced equation
        GMM-type: L(2/.).growth L(2/.).initial L(2/.).lnunderval_5
                  L(2/.).lncapital_5 L(2/.).lnlabour_5 L(2/.).lnUNDERVAL_lnlabour
                  L(2/.).lnUNDERVAL_lncapital L(2/.).lnUNDERVAL_initial
Instruments for level equation
```

ARELLANO AND BOND AR (2) TEST

Arellano-Bond test for zero autocorrelation in first-differenced errors

Order	z	Prob > z
1	-1.8429	0.0653
2	-.89591	0.3703

H0: no autocorrelation

SARGAN TEST

```
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(30)     =  18.37654
        Prob > chi2  =    0.9521
```

APPENDIX E: MODEL BASED MEASURE OF UNDERVALUATION

```
System dynamic panel-data estimation          Number of obs      =        72
Group variable: id                            Number of groups   =         6
Time variable: year
                                              Obs per group:   min =      12
                                                               avg =      12
                                                               max =      12

Number of instruments =    116                Wald chi2(5)       =  11282.34
                                              Prob > chi2        =    0.0000
One-step results
------------------------------------------------------------------------------
             |               Robust
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |  -.0772559   .1383265    -0.56   0.577    -.3483707     .193859
             |
     initial |  -.0279461   .0105804    -2.64   0.008    -.0486832   -.0072089
   lncapital |   .0349519   .0131147     2.67   0.008     .0092475    .0606563
    lnlabour |    .012479    .016697     0.75   0.455    -.0202465    .0452046
 lnunderval  |   .0272756   .0073656     3.70   0.000     .0128394    .0417119
       _cons |  -.1106939   .1060778    -1.04   0.297    -.3186026    .0972148
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).growth L(2/.).initial L(2/.).lncapital
                  L(2/.).lnlabour L(2/.).lnunderval
Instruments for level equation
        GMM-type: LD.growth LD.initial LD.lncapital LD.lnlabour
                  LD.lnunderval
        Standard: _cons
```

ARELLANO AND BOND AR (2) TEST

```
Arellano-Bond test for zero autocorrelation in first-differenced errors

  +-----------------------+
  |Order |  z     Prob > z|
  |------+----------------|
  |   1  |-1.7373  0.0823 |
  |   2  |-1.2483  0.2119 |
  +-----------------------+
   H0: no autocorrelation
```

SARGAN TEST

```
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(110)     =  117.9893
        Prob > chi2   =    0.2841
```

POOLED LEAST SQUARES

Source	SS	df	MS
Model	.005327293	4	.001331823
Residual	.020038223	67	.000299078
Total	.025365516	71	.000357261

Number of obs	=	72
F(4, 67)	=	4.45
Prob > F	=	0.0030
R-squared	=	0.2100
Adj R-squared	=	0.1629
Root MSE	=	.01729

growth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	-.0198466	.0071974	-2.76	0.008	-.0342127	-.0054804
lncapital	.0219776	.0067651	3.25	0.002	.0084744	.0354809
lnlabour	.0116444	.0081362	1.43	0.157	-.0045956	.0278843
lnunderval	.0263172	.0131427	2.00	0.049	.0000842	.0525502
_cons	-.0772991	.060179	-1.28	0.203	-.1974169	.0428187

HETEROSCEDASTICITY TEST

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of growth

         chi2(1)      =     2.34
         Prob > chi2  =   0.1258
```

MODEL SPECIFICATION TEST

```
Ramsey RESET test using powers of the fitted values of growth
       Ho:  model has no omitted variables
                  F(3, 64) =      3.66
                  Prob > F =      0.0169
```

FIXED EFFECTS REGRESSION

```
Fixed-effects (within) regression               Number of obs      =        72
Group variable: id                              Number of groups   =         6

R-sq:  within  = 0.2778                         Obs per group: min =        12
       between = 0.4832                                        avg =      12.0
       overall = 0.1571                                        max =        12

                                                F(4,62)            =      5.96
corr(u_i, Xb)  = -0.9890                        Prob > F           =    0.0004
```

growth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	-.1468133	.0350867	-4.18	0.000	-.2169506	-.076676
lncapital	.2488168	.1045239	2.38	0.020	.0398765	.4577571
lnlabour	.0270319	.0257074	1.05	0.297	-.0243564	.0784201
lnunderval	.0434698	.0122562	3.55	0.001	.01897	.0679696
_cons	-.767484	.4839884	-1.59	0.118	-1.734963	.199995
sigma_u	.07638967					
sigma_e	.01489052					
rho	.96339381	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(5, 62) =      5.67             Prob > F = 0.0002
```

RANDOM EFFECTS REGRESSION

```
R-sq:  within  = 0.1949                         Obs per group: min =        12
       between = 0.3836                                        avg =      12.0
       overall = 0.1785                                        max =        12

                                                Wald chi2(4)       =     12.31
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0152
```

growth	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
initial	-.0405328	.0143644	-2.82	0.005	-.0686866	-.0123791
lncapital	.0292487	.0154191	1.90	0.058	-.0009722	.0594697
lnlabour	.0101996	.0157688	0.65	0.518	-.0207068	.0411059
lnunderval	.0300386	.0123072	2.44	0.015	.0059169	.0541604
_cons	.0047293	.1186584	0.04	0.968	-.2278369	.2372954
sigma_u	.00992246					
sigma_e	.01489052					
rho	.30749692	(fraction of variance due to u_i)				

EQUILIBRIUM REAL EXCHANGE RATE MODEL

Dependent Variable: LOG(RER)
Method: Dynamic Least Squares (DOLS)
Date: 09/10/16 Time: 08:35
Sample (adjusted): 1988 2013
Included observations: 26 after adjustments
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=2)
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(OPN)	-0.903725	0.288740	-3.129895	0.0260
LOG(GDP)	-8.559364	4.858879	-1.761592	0.1384
LOG(GCONS)	24.49484	11.67653	2.097785	0.0900
LOG(CPFLOW)	0.591284	0.514824	-1.148518	0.3027
C	-449.0673	218.4127	-2.056050	0.0949

R-squared	0.893762	Mean dependent var	5.566380
Adjusted R-squared	0.468810	S.D. dependent var	1.050536
S.E. of regression	0.765660	Sum squared resid	2.931174

COINTEGRATION TESTS

Cointegration Test - Hansen Parameter Instability
Date: 09/09/16 Time: 19:36
Equation: UNTITLED
Null hypothesis: Series are cointegrated
Cointegrating equation deterministics: C @TREND
HAC score variance
No d.f. adjustment for score variance

Lc statistic	Stochastic Trends (m)	Deterministic Trends (k)	Excluded Trends (p2)	Prob.*
0.460182	3	1	0	> 0.2

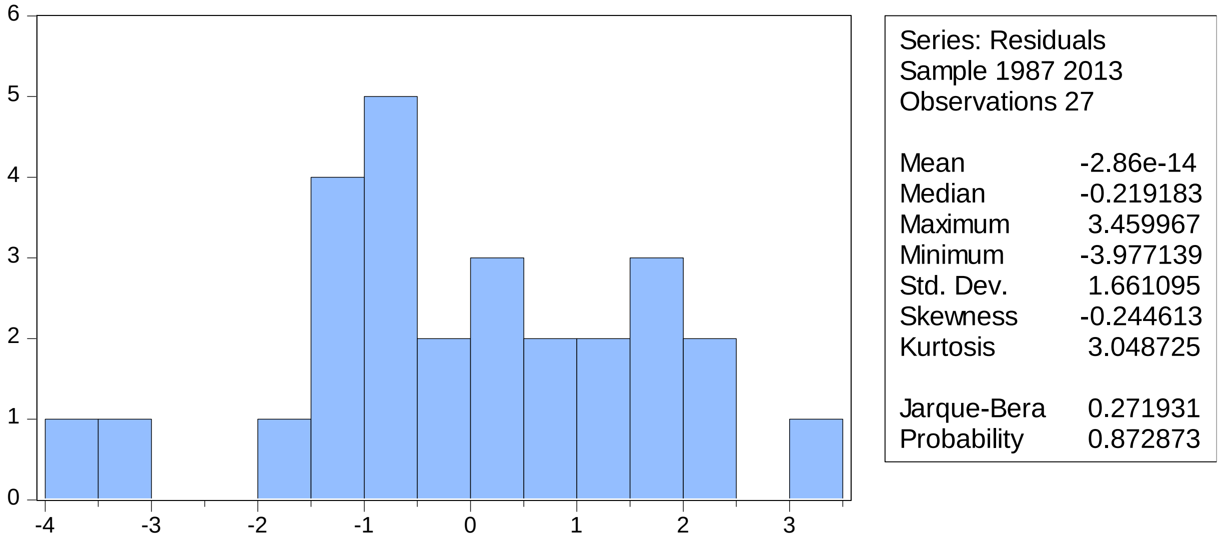
*Hansen (1992b) Lc(m2=3, k=1) p-values, where m2=m-p2 is the number of stochastic trends in the asymptotic distribution

Cointegration Test - Engle-Granger
Date: 09/09/16 Time: 19:37
Equation: UNTITLED
Cointegrating equation deterministics: C @TREND
Null hypothesis: Series are not cointegrated
Automatic lag specification (lag=0 based on Schwarz Info Criterion, maxlag=5)

	Value	Prob.*
Engle-Granger tau-statistic	-6.124828	0.0053
Engle-Granger z-statistic	-33.11575	0.0047

*MacKinnon (1996) p-values.

RESIDUAL NORMALITY



MODEL SPECIFICATION TEST

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values

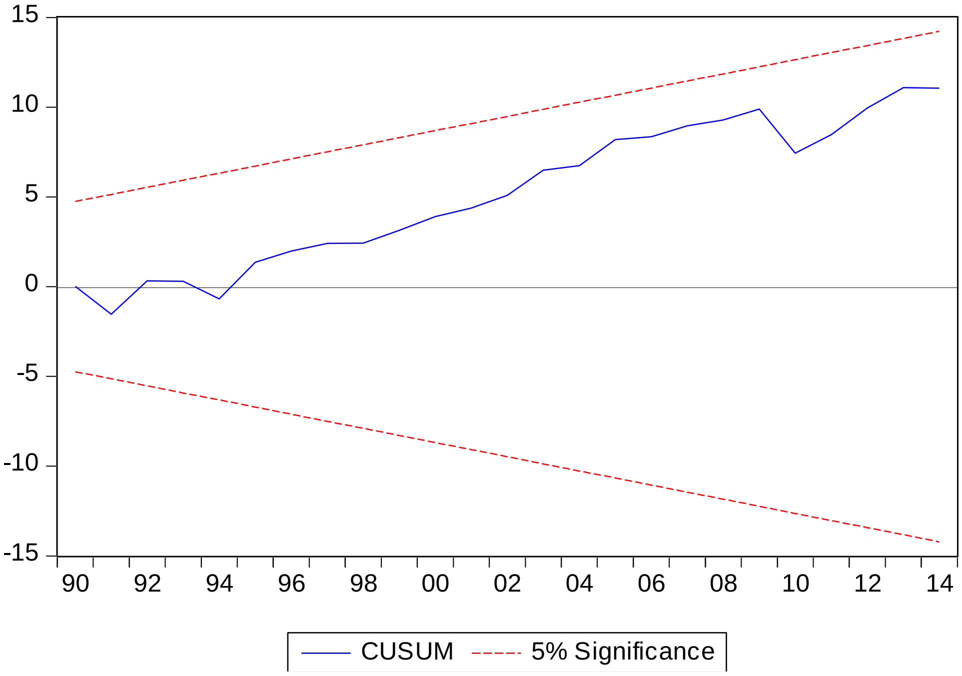
	Value	df	Probability
t-statistic	1.148425	24	0.2621
F-statistic	1.318880	(1, 24)	0.2621
Likelihood ratio	1.604896	1	0.2052

AUTOCORRELATION TEST

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.767774	Prob. F(2,23)	0.4756
Obs*R-squared	1.877538	Prob. Chi-Square(2)	0.3911

PARAMETER STABILITY



APPENDIX F: BALASSA UNADJUSTED MEASURE

BLUNDELL AND BOND SYSTEM GMM ONE STEP ESTIMATES

```
Group variable: id                          Number of groups      =          6
Time variable: year
                                            Obs per group:    min =         25
                                                              avg =         25
                                                              max =         25

Number of instruments =     266             Wald chi2(5)          =     300.03
                                            Prob > chi2           =     0.0000
One-step results
```

growth	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth						
L1.	-.0252741	.1420723	-0.18	0.859	-.3037307	.2531825
initial	-.0117195	.0039534	-2.96	0.003	-.019468	-.003971
lnlabour	.0162973	.0039557	4.12	0.000	.0085443	.0240503
lncapital	.0150293	.006905	2.18	0.030	.0014957	.0285629
lnunderval	.0152293	.0061804	2.46	0.014	.003116	.0273427
_cons	-.1149947	.0388751	-2.96	0.003	-.1911884	-.0388009

```
Instruments for differenced equation
        GMM-type: L(2/.).growth L(2/.).initial L(2/.).lnlabour
                  L(2/.).lncapital L(2/.).lnunderval
Instruments for level equation
        GMM-type: LD.growth LD.initial LD.lnlabour LD.lncapital
                  LD.lnunderval
        Standard: _cons
```

ARELLANO AND BOND AR (2) TEST

Arellano-Bond test for zero autocorrelation in first-differenced errors

Order	z	Prob > z
1	-2.1516	0.0314
2	-.69821	0.4850

H0: no autocorrelation

SARGAN TEST

```
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(260)     =  257.6812
        Prob > chi2   =    0.5290
```

POOLED LEAST SQUARES

```
             |                                         F(  4,    145) =    2.34
       Model |  .003993227     4  .000998307           Prob > F      =  0.0582
    Residual |  .061950353   145  .000427244           R-squared     =  0.0606
-------------+----------------------------------       Adj R-squared =  0.0346
       Total |  .065943581   149  .000442574           Root MSE      =  .02067
```

growth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	-.0089336	.0060043	-1.49	0.139	-.0208009	.0029338
lnlabour	.014056	.0063618	2.21	0.029	.0014821	.0266299
lncapital	.0096826	.0056678	1.71	0.090	-.0015195	.0208847
lnunderval	.0149163	.0195681	0.76	0.447	-.0237592	.0535918
_cons	-.0860679	.0447353	-1.92	0.056	-.1744854	.0023495

HETEROSCEDASTICITY

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of growth

         chi2(1)      =     0.96
         Prob > chi2  =   0.3267
```

MODEL SPECIFICATION

```
Ramsey RESET test using powers of the fitted values of growth
       Ho:  model has no omitted variables
                 F(3, 142) =      0.70
                  Prob > F =      0.5518
```

FIXED EFFECTS REGRESSION

```
Group variable: id                              Number of groups   =         6

R-sq:  within  = 0.0185                         Obs per group: min =        25
       between = 0.0072                                        avg =      25.0
       overall = 0.0000                                        max =        25

                                                F(4,140)           =      0.66
corr(u_i, Xb)  = -0.8971                        Prob > F           =    0.6216
```

growth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
initial	-.0061141	.0223095	-0.27	0.784	-.0502211	.0379928
lnlabour	.0305337	.021164	1.44	0.151	-.0113087	.072376
lncapital	-.035334	.057759	-0.61	0.542	-.1495266	.0788587
lnunderval	.0269165	.0248609	1.08	0.281	-.0222348	.0760678
_cons	.0507187	.2371577	0.21	0.831	-.4181549	.5195923
sigma_u	.01644002					
sigma_e	.02058923					
rho	.38933715	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(5, 140) =     1.23             Prob > F = 0.2994
```

RANDOM EFFECTS REGRESSION

```
Group variable: id                              Number of groups   =         6

R-sq:  within  = 0.0131                         Obs per group: min =        25
       between = 0.5887                                        avg =      25.0
       overall = 0.0603                                        max =        25

                                                Wald chi2(4)       =      4.79
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.3098
```

growth	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
initial	-.0096301	.0089253	-1.08	0.281	-.0271234	.0078632
lnlabour	.0154656	.0093638	1.65	0.099	-.0028872	.0338184
lncapital	.0091642	.0089268	1.03	0.305	-.008332	.0266605
lnunderval	.0155327	.0198487	0.78	0.434	-.02337	.0544354
_cons	-.0881666	.0661254	-1.33	0.182	-.21777	.0414368
sigma_u	.00519435					
sigma_e	.02058923					
rho	.05983891	(fraction of variance due to u_i)				

APPENDIX G: PANEL DIAGNOSTICS

ENDOGENEITY

```
Tests of endogeneity
Ho: variables are exogenous

Durbin (score) chi2(1)          =  5.47103  (p = 0.0193)
Wu-Hausman F(1,12)              =  5.24004  (p = 0.0410)
```

CROSS SECTIONAL DEPENDENCY

```
Pesaran's test of cross sectional independence =     0.966, Pr = 0.3340

Average absolute value of the off-diagonal elements =     0.416
```

APPENDIX H: PANEL TIME SERIES EVIDENCE

STATIONARITY TESTS

Pesaran Panel Unit Root Test with cross-sectional and first difference mean included for lnoutput_
Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS = -1.365 N,T = (6,29)

	10%	5%	1%
Critical values at	-2.12	-2.25	-2.51

Pesaran Panel Unit Root Test with cross-sectional and first difference mean included for D.lnoutput_
Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS = -4.060 N,T = (6,28)

	10%	5%	1%
Critical values at	-2.12	-2.25	-2.51

Pesaran Panel Unit Root Test with cross-sectional and first difference mean included for lnlabou
Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS = -1.640 N,T = (6,30)

	10%	5%	1%
Critical values at	-2.12	-2.25	-2.51

Pesaran Panel Unit Root Test with cross-sectional and first difference mean included for D.lnlabour
Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS = -3.643 N,T = (6,29)

	10%	5%	1%
Critical values at	-2.12	-2.25	-2.51

Pesaran Panel Unit Root Test with cross-sectional and first difference mean included for lncapital
Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

Individual ti were truncated during the aggregation process

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS* = -0.046 N,T = (6,30)

	10%	5%	1%
Critical values at	-2.1	-2.22	-2.44

Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS = -4.060 N,T = (6,28)

	10%	5%	1%
Critical values at	-2.12	-2.25	-2.51

Pesaran Panel Unit Root Test with cross-sectional and first difference mean included for underval
Deterministics chosen: constant

Dynamics: lags criterion decision General to Particular based on F joint test

Individual ti were truncated during the aggregation process

H0 (homogeneous non-stationary): bi = 0 for all i

CIPS* = 2.610 N,T = (6,30)

	10%	5%	1%
Critical values at	-2.1	-2.22	-2.44

```
Breitung unit-root test for lnoutput_
-------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     29

AR parameter: Common                    Asymptotics:  T,N -> Infinity
Panel means:  Included                                  sequentially
Time trend:   Included                  Prewhitening: Not performed
                                        Cross-sectional means removed
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 lambda*               0.2868        0.6128
------------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for D.lnoutput_
---------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     28

AR parameter: Common                    Asymptotics:  T,N -> Infinity
Panel means:  Included                                  sequentially
Time trend:   Included                  Prewhitening: Not performed
                                        Cross-sectional means removed
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 lambda*              -5.0057        0.0000
------------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for lncapital
-------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     30

AR parameter: Common                    Asymptotics:  T,N -> Infinity
Panel means:  Not included                              sequentially
Time trend:   Not included              Prewhitening: Not performed
                                        Cross-sectional means removed
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 lambda*               3.7982        0.9999
------------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for D.lncapital
-----------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     29

AR parameter: Common                       Asymptotics:  T,N -> Infinity
Panel means:  Not included                                  sequentially
Time trend:   Not included                 Prewhitening: Not performed
                                           Cross-sectional means removed
------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------
 lambda*              -2.3437        0.0095
------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for lnlabour
--------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     30

AR parameter: Common                       Asymptotics:  T,N -> Infinity
Panel means:  Not included                                  sequentially
Time trend:   Not included                 Prewhitening: Not performed
                                           Cross-sectional means removed
------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------
 lambda*               1.3806        0.9163
------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for D.lnlabour
----------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     29

AR parameter: Common                       Asymptotics:  T,N -> Infinity
Panel means:  Not included                                  sequentially
Time trend:   Not included                 Prewhitening: Not performed
                                           Cross-sectional means removed
------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------
 lambda*              -4.6844        0.0000
------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for underval
----------------------------------------
Ho: Panels contain unit roots            Number of panels  =      6
Ha: Panels are stationary                Number of periods =     30

AR parameter: Common                     Asymptotics:  T,N -> Infinity
Panel means:  Included                                  sequentially
Time trend:   Not included               Prewhitening: 1 lag
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 lambda*             -0.4612        0.3223
------------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Breitung unit-root test for D.underval
------------------------------------------
Ho: Panels contain unit roots            Number of panels  =      6
Ha: Panels are stationary                Number of periods =     29

AR parameter: Common                     Asymptotics:  T,N -> Infinity
Panel means:  Included                                  sequentially
Time trend:   Not included               Prewhitening: 1 lag
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 lambda*             -1.8930        0.0292
------------------------------------------------------------------------------
 * Lambda robust to cross-sectional correlation
```

```
Hadri LM test for lnoutput_
------------------------------
Ho: All panels are stationary            Number of panels  =      6
Ha: Some panels contain unit roots       Number of periods =     29

Time trend:         Included             Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                  sequentially
LR variance:        (not used)           Cross-sectional means removed
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 z                   17.9693        0.0000
------------------------------------------------------------------------------
```

```
Hadri LM test for D.lnoutput_
-------------------------------------
Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     28

Time trend:           Included             Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                   sequentially
LR variance:          (not used)           Cross-sectional means removed
------------------------------------------------------------------------------
                      Statistic       p-value
------------------------------------------------------------------------------
 z                      0.1414         0.4438
------------------------------------------------------------------------------

Hadri LM test for lncapital
-----------------------------------
Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     30

Time trend:           Included             Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                   sequentially
LR variance:          (not used)           Cross-sectional means removed
------------------------------------------------------------------------------
                      Statistic       p-value
------------------------------------------------------------------------------
 z                     19.4153         0.0000
------------------------------------------------------------------------------

-------------------------------------
Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     28

Time trend:           Included             Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                   sequentially
LR variance:          (not used)           Cross-sectional means removed
------------------------------------------------------------------------------
                      Statistic       p-value
------------------------------------------------------------------------------
 z                      0.1414         0.4438
------------------------------------------------------------------------------

Hadri LM test for lnlabour
---------------------------------
Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     30

Time trend:           Included             Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                   sequentially
LR variance:          (not used)           Cross-sectional means removed
------------------------------------------------------------------------------
                      Statistic       p-value
------------------------------------------------------------------------------
 z                     26.1838         0.0000
------------------------------------------------------------------------------
```

```
Hadri LM test for D.lnlabour

Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     29

Time trend:          Included              Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                  sequentially
LR variance:         (not used)            Cross-sectional means removed
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 z                     1.1235        0.1306
------------------------------------------------------------------------------

Hadri LM test for underval

Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     30

Time trend:          Not included          Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                  sequentially
LR variance:         (not used)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 z                    27.1791        0.0000
------------------------------------------------------------------------------

Hadri LM test for D.underval

Ho: All panels are stationary              Number of panels  =      6
Ha: Some panels contain unit roots         Number of periods =     29

Time trend:          Not included          Asymptotics: T, N -> Infinity
Heteroskedasticity: Robust                                  sequentially
LR variance:         (not used)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 z                    -0.6548        0.7437
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for lnoutput_
------------------------------------------
Ho: Panels contain unit roots               Number of panels  =      6
Ha: Panels are stationary                   Number of periods =     29

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included                      Cross-sectional means removed

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -6.1339
 Adjusted t*          -2.3581        0.0092
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for lncapital
------------------------------------------
Ho: Panels contain unit roots               Number of panels  =      6
Ha: Panels are stationary                   Number of periods =     30

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included                      Cross-sectional means removed

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -5.2363
 Adjusted t*           0.6128        0.7300
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for D.lncapital
--------------------------------------------
Ho: Panels contain unit roots               Number of panels  =      6
Ha: Panels are stationary                   Number of periods =     29

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included                      Cross-sectional means removed

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                    Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -6.1339
 Adjusted t*          -2.3581        0.0092
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for lnlabour
--------------------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     30

AR parameter: Common                    Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included                  Cross-sectional means removed

ADF regressions: 1 lag
LR variance:    Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -2.8431
 Adjusted t*          -0.3732        0.3545
------------------------------------------------------------------------------


Levin-Lin-Chu unit-root test for D.lnlabour
----------------------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     29

AR parameter: Common                    Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Included                  Cross-sectional means removed

ADF regressions: 1 lag
LR variance:    Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t         -9.9389
 Adjusted t*          -4.7841        0.0000
------------------------------------------------------------------------------

Levin-Lin-Chu unit-root test for underval
--------------------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     30

AR parameter: Common                    Asymptotics: root(N)/T -> 0
Panel means:  Not included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:    Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t          0.3420        0.6338
 Adjusted t*           0.3232        0.6267
------------------------------------------------------------------------------
```

```
Levin-Lin-Chu unit-root test for D.underval
-----------------------------------------------------
Ho: Panels contain unit roots           Number of panels  =      6
Ha: Panels are stationary               Number of periods =     29

AR parameter: Common                    Asymptotics: root(N)/T -> 0
Panel means:  Not included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:    Bartlett kernel, 9.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t          -9.8903       0.0000
 Adjusted t*           -9.5063       0.0000
------------------------------------------------------------------------------

Im-Pesaran-Shin unit-root test for lnoutput_
-------------------------------------------------------
Ho: All panels contain unit roots       Number of panels  =      6
Ha: Some panels are stationary          Number of periods =     29

AR parameter: Panel-specific            Asymptotics: T,N -> Infinity
Panel means:  Included                                   sequentially
Time trend:   Included                  Cross-sectional means removed

ADF regressions: No lags included
------------------------------------------------------------------------------
                                          Fixed-N exact critical values
                     Statistic      p-value         1%        5%        10%
------------------------------------------------------------------------------
 t-bar                 -1.7509                    -2.930    -2.690    -2.570
 t-tilde-bar           -1.6404
 Z-t-tilde-bar         -0.6363       0.2623
------------------------------------------------------------------------------

Im-Pesaran-Shin unit-root test for D.lnoutput_
---------------------------------------------------------
Ho: All panels contain unit roots       Number of panels  =      6
Ha: Some panels are stationary          Number of periods =     28

AR parameter: Panel-specific            Asymptotics: T,N -> Infinity
Panel means:  Included                                   sequentially
Time trend:   Included                  Cross-sectional means removed

ADF regressions: No lags included
------------------------------------------------------------------------------
                                          Fixed-N exact critical values
                     Statistic      p-value         1%        5%        10%
------------------------------------------------------------------------------
 t-bar                 -4.6284                    -2.930    -2.690    -2.570
 t-tilde-bar           -3.4527
 Z-t-tilde-bar         -6.2976       0.0000
------------------------------------------------------------------------------
```

```
Im-Pesaran-Shin unit-root test for lncapital
--------------------------------------------
Ho: All panels contain unit roots           Number of panels  =      6
Ha: Some panels are stationary              Number of periods =     30

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                        sequentially
Time trend:   Included                      Cross-sectional means removed

ADF regressions: No lags included
------------------------------------------------------------------------------
                                              Fixed-N exact critical values
                     Statistic      p-value        1%       5%       10%
------------------------------------------------------------------------------
 t-bar                -0.6785                    -2.930   -2.690   -2.570
 t-tilde-bar          -0.6509
 Z-t-tilde-bar         2.4457        0.9928
------------------------------------------------------------------------------

----------------------------------------------
Ho: All panels contain unit roots           Number of panels  =      6
Ha: Some panels are stationary              Number of periods =     28

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                        sequentially
Time trend:   Included                      Cross-sectional means removed

ADF regressions: No lags included
------------------------------------------------------------------------------
                                              Fixed-N exact critical values
                     Statistic      p-value        1%       5%       10%
------------------------------------------------------------------------------
 t-bar                -4.6284                    -2.930   -2.690   -2.570
 t-tilde-bar          -3.4527
 Z-t-tilde-bar        -6.2976        0.0000
------------------------------------------------------------------------------
```

```
Im-Pesaran-Shin unit-root test for lnlabour
-------------------------------------------
Ho: All panels contain unit roots           Number of panels  =      6
Ha: Some panels are stationary              Number of periods =     30

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                        sequentially
Time trend:   Included                      Cross-sectional means removed

ADF regressions: No lags included
------------------------------------------------------------------------------
                                            Fixed-N exact critical values
                    Statistic      p-value       1%        5%        10%
------------------------------------------------------------------------------
 t-bar               -1.0543                   -2.930    -2.690    -2.570
 t-tilde-bar         -1.0003
 Z-t-tilde-bar        1.3615         0.9133
------------------------------------------------------------------------------

Im-Pesaran-Shin unit-root test for D.lnlabour
---------------------------------------------
Ho: All panels contain unit roots           Number of panels  =      6
Ha: Some panels are stationary              Number of periods =     29

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                        sequentially
Time trend:   Included                      Cross-sectional means removed

ADF regressions: No lags included
------------------------------------------------------------------------------
                                            Fixed-N exact critical values
                    Statistic      p-value       1%        5%        10%
------------------------------------------------------------------------------
 t-bar               -4.3528                   -2.930    -2.690    -2.570
 t-tilde-bar         -3.3352
 Z-t-tilde-bar       -5.9077         0.0000
------------------------------------------------------------------------------

Im-Pesaran-Shin unit-root test for underval
-------------------------------------------
Ho: All panels contain unit roots           Number of panels  =      6
Ha: Some panels are stationary              Number of periods =     30

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                        sequentially
Time trend:   Included

ADF regressions: No lags included
------------------------------------------------------------------------------
                                            Fixed-N exact critical values
                    Statistic      p-value       1%        5%        10%
------------------------------------------------------------------------------
 t-bar               -1.8948                   -2.930    -2.690    -2.570
 t-tilde-bar         -1.8220
 Z-t-tilde-bar       -1.1887         0.1173
------------------------------------------------------------------------------
```

```
Im-Pesaran-Shin unit-root test for D.underval
---------------------------------------------
Ho: All panels contain unit roots           Number of panels  =      6
Ha: Some panels are stationary              Number of periods =     29

AR parameter: Panel-specific                Asymptotics: T,N -> Infinity
Panel means:  Included                                     sequentially
Time trend:   Included

ADF regressions: No lags included
------------------------------------------------------------------------------
                                            Fixed-N exact critical values
                     Statistic      p-value         1%        5%       10%
------------------------------------------------------------------------------
 t-bar                -3.4453                    -2.930    -2.690    -2.570
 t-tilde-bar          -2.9474
 Z-t-tilde-bar        -4.7015        0.0000
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for lnoutput_
--------------------------------------------
Ho: Panels contain unit roots               Number of panels  =      6
Ha: Panels are stationary                   Number of periods =     29

AR parameter: Common                        Asymptotics: N -> Infinity
Panel means:  Included                                   T Fixed
Time trend:   Included
------------------------------------------------------------------------------
                     Statistic          z          p-value
------------------------------------------------------------------------------
 rho                    0.8450       1.3831         0.9167
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for D.lnoutput_
----------------------------------------------
Ho: Panels contain unit roots               Number of panels  =      6
Ha: Panels are stationary                   Number of periods =     28

AR parameter: Common                        Asymptotics: N -> Infinity
Panel means:  Included                                   T Fixed
Time trend:   Included
------------------------------------------------------------------------------
                     Statistic          z          p-value
------------------------------------------------------------------------------
 rho                    0.2110      -8.3178         0.0000
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for lncapital
--------------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     30

AR parameter: Common                       Asymptotics: N -> Infinity
Panel means:  Included                                  T Fixed
Time trend:   Included
------------------------------------------------------------------------------
                   Statistic          z          p-value
------------------------------------------------------------------------------
 rho                 1.0098        4.0025       1.0000
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for D.lncapital
----------------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     29

AR parameter: Common                       Asymptotics: N -> Infinity
Panel means:  Not included                              T Fixed
Time trend:   Not included                 Cross-sectional means removed
------------------------------------------------------------------------------
                   Statistic          z          p-value
------------------------------------------------------------------------------
 rho                 0.8731       -6.2633       0.0000
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for lnlabour
-------------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     30

AR parameter: Common                       Asymptotics: N -> Infinity
Panel means:  Included                                  T Fixed
Time trend:   Included
------------------------------------------------------------------------------
                   Statistic          z          p-value
------------------------------------------------------------------------------
 rho                 0.9121        2.4015       0.9918
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for D.lnlabour
---------------------------------------------
Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     29

AR parameter: Common                       Asymptotics: N -> Infinity
Panel means:  Included                                  T Fixed
Time trend:   Included
------------------------------------------------------------------------------
                   Statistic          z          p-value
------------------------------------------------------------------------------
 rho                 0.4303       -5.2145       0.0000
------------------------------------------------------------------------------
```

```
Harris-Tzavalis unit-root test for underval

Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     30

AR parameter: Common                       Asymptotics: N -> Infinity
Panel means:  Included                                  T Fixed
Time trend:   Included

                    Statistic          z          p-value

rho                   0.7682        0.0429        0.5171
```

```
Harris-Tzavalis unit-root test for D.underval

Ho: Panels contain unit roots              Number of panels  =      6
Ha: Panels are stationary                  Number of periods =     29

AR parameter: Common                       Asymptotics: N -> Infinity
Panel means:  Included                                  T Fixed
Time trend:   Included

                    Statistic          z          p-value

rho                   0.3571       -6.3802        0.0000
```

COINTEGRATION TESTS

Pedroni Residual Cointegration Test
Series: LNOUTPUT LNLABOUR LNCAPITAL UNDERVAL
Date: 09/24/16 Time: 12:01
Sample: 1985 2014
Included observations: 180
Cross-sections included: 6
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.434593	0.6681	-1.042622	0.8514
Panel rho-Statistic	-3.676536	0.0001	-1.942845	0.0260
Panel PP-Statistic	-11.96667	0.0000	-7.573549	0.0000
Panel ADF-Statistic	-5.837496	0.0000	-3.928122	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	-1.604303	0.0543
Group PP-Statistic	-10.37321	0.0000
Group ADF-Statistic	-5.025131	0.0000

Kao Residual Cointegration Test
Series: LNOUTPUT LNLABOUR LNCAPITAL UNDERVAL
Date: 09/24/16 Time: 12:03
Sample: 1985 2014
Included observations: 180
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-4.548115	0.0000
Residual variance	0.000793	
HAC variance	0.000275	

Johansen Fisher Panel Cointegration Test
Series: LNOUTPUT LNLABOUR LNCAPITAL UNDERVAL
Date: 09/24/16 Time: 12:05
Sample: 1985 2014
Included observations: 180
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	67.54	0.0000	44.78	0.0000
At most 1	27.58	0.0064	27.58	0.0064
At most 2	25.38	0.0131	18.11	0.1124
At most 3	33.64	0.0008	18.60	0.0987

* Probabilities are computed using asymptotic Chi-square distribution.

WESTERLUND

Results for H0: no cointegration
With 6 series and 3 covariates

Statistic	Value	Z-value	P-value
Gt	-3.477	-4.229	0.000
Ga	-14.470	-2.611	0.005
Pt	-10.535	-5.577	0.000
Pa	-17.888	-5.282	0.000

APPENDIX I: DYNAMIC ESTIMATORS

POOLED MEAN GROUP

```
Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): id                          Number of obs      =        90
Time Variable (t): year                         Number of groups   =         6
                                                Obs per group: min =        15
                                                               avg =      15.0
                                                               max =        15

                                                Log Likelihood     =  312.0905
```

D.lnoutput	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ec						
lnlabour L1.	-.0522604	.1814279	-0.29	0.773	-.4078526	.3033318
lncapital L1.	.4799331	.422661	1.14	0.256	-.3484673	1.308333
underval L1.	.2261263	.0658557	3.43	0.001	.0970516	.3552011
SR						
ec	-.2236304	.0629169	-3.55	0.000	-.3469453	-.1003155
lnlabour D1.	.0784597	.059737	1.31	0.189	-.0386227	.1955422
lncapital D1.	.6374403	.4866488	1.31	0.190	-.3163738	1.591254
underval D1.	.0022583	.0247709	0.09	0.927	-.0462917	.0508083
_cons	.7512633	.2316275	3.24	0.001	.2972818	1.205245

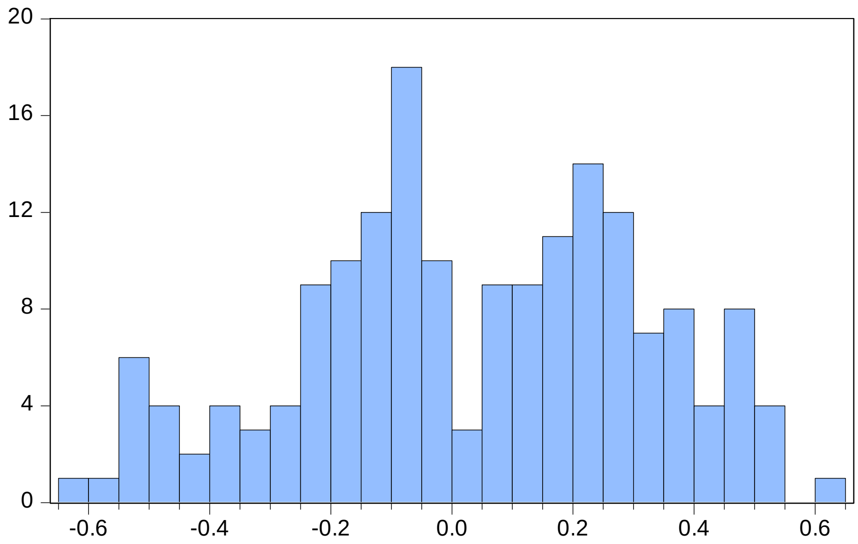
DYNAMIC ORDINARY LEAST SQUARES

Dependent Variable: LNOUTPUT
Method: Panel Dynamic Least Squares (DOLS)
Date: 09/25/16 Time: 16:15
Sample (adjusted): 1987 2013
Periods included: 27
Cross-sections included: 6
Total panel (balanced) observations: 162
Panel method: Grouped estimation
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=1)
Long-run variances (Bartlett kernel, Newey-West fixed bandwidth) used for
individual coefficient covariances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNLABOUR	0.898906	0.208228	4.316924	0.0000
LNCAPITAL	1.188992	0.227992	5.215059	0.0000
UNDERVAL	0.294144	0.052215	5.633283	0.0000

R-squared	-3425.841703	Mean dependent var	5.635627
Adjusted R-squared	-5571.944588	S.D. dependent var	0.332654
S.E. of regression	24.83332	Sum squared resid	61052.69
Long-run variance	0.000632		

RESIDUAL NORMALITY



Series: Residuals
Sample 1986 2014
Observations 174

Mean	0.034505
Median	0.038485
Maximum	0.600523
Minimum	-0.602955
Std. Dev.	0.281000
Skewness	-0.196961
Kurtosis	2.325356
Jarque-Bera	4.424820
Probability	0.109437

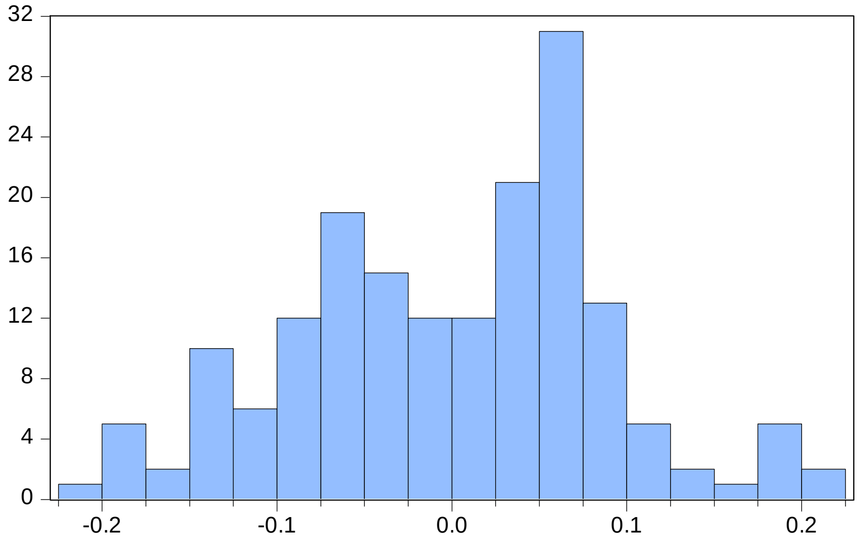
FULLY MODIFIED ORDINARY LEAST SQUARES

Dependent Variable: LNOUTPUT
Method: Panel Fully Modified Least Squares (FMOLS)
Date: 09/25/16 Time: 16:10
Sample (adjusted): 1986 2014
Periods included: 29
Cross-sections included: 6
Total panel (balanced) observations: 174
Panel method: Grouped estimation
Cointegrating equation deterministics: C
Long-run covariance estimates (Bartlett kernel, Newey-West automatic bandwidth, NW automatic lag length)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNLABOUR	0.193196	0.019500	9.907514	0.0000
LNCAPITAL	1.053305	0.016313	64.56673	0.0000
LNUNDERVAL	0.244497	0.047673	5.128666	0.0000

R-squared	0.931929	Mean dependent var	5.635930
Adjusted R-squared	0.928629	S.D. dependent var	0.334882
S.E. of regression	0.089465	Sum squared resid	1.320655
Long-run variance	0.004286		

RESIDUAL NORMALITY



Series: Residuals
Sample 1986 2014
Observations 174

Mean	2.94e-16
Median	0.009516
Maximum	0.224540
Minimum	-0.217060
Std. Dev.	0.088190
Skewness	-0.077110
Kurtosis	2.636294
Jarque-Bera	1.131479
Probability	0.567940

OTHER PANEL TIME SERIES ESTIMATORS

AUGMENTED MEAN GROUP

Group-specific coefficients

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Group 1						
lncapital	-.5187959	.2161009	-2.40	0.016	-.9423458	-.0952459
lnlabour	-.0742955	.1307665	-0.57	0.570	-.3305931	.1820022
underval	.1182368	.0616713	1.92	0.055	-.0026367	.2391103
__00000R_c	-.1687356	.2468302	-0.68	0.494	-.6525139	.3150427
__000007_t	.0067085	.0061944	1.08	0.279	-.0054323	.0188494
_cons	8.785942	.610031	14.40	0.000	7.590304	9.981581
Group 2						
lncapital	.4985724	.1454114	3.43	0.001	.2135714	.7835735
lnlabour	.3239908	.1735422	1.87	0.062	-.0161457	.6641274
underval	-.1056044	.0416141	-2.54	0.011	-.1871665	-.0240422
__00000R_c	1.199875	.1226941	9.78	0.000	.9593992	1.440351
__000007_t	-.0022826	.0025043	-0.91	0.362	-.007191	.0026258
_cons	1.026232	1.011357	1.01	0.310	-.9559914	3.008456
Group 3						
lncapital	-.3995751	.6026697	-0.66	0.507	-1.580786	.7816359
lnlabour	-.2662432	.0893369	-2.98	0.003	-.4413402	-.0911461
underval	-.08941	.0696103	-1.28	0.199	-.2258436	.0470236
__00000R_c	.2870349	.1878547	1.53	0.127	-.0811535	.6552234
__000007_t	.0086428	.0029663	2.91	0.004	.0028289	.0144567
_cons	8.704328	3.73394	2.33	0.020	1.385941	16.02272
Group 4						
lncapital	.5522365	.196701	2.81	0.005	.1667097	.9377633
lnlabour	-.0882267	.0927148	-0.95	0.341	-.2699444	.0934909
underval	-.0697364	.0342715	-2.03	0.042	-.1369073	-.0025654
__00000R_c	1.218008	.142821	8.53	0.000	.9380835	1.497932
__000007_t	-.0048231	.0014393	-3.35	0.001	-.0076442	-.0020021
_cons	3.173718	.7940918	4.00	0.000	1.617326	4.730109

Group 5						
lncapital	.115995	.5365773	0.22	0.829	-.9356772	1.167667
lnlabour	-.1420018	.0970717	-1.46	0.144	-.3322588	.0482551
underval	-.060591	.0476835	-1.27	0.204	-.154049	.0328669
__00000R_c	1.866205	.1482811	12.59	0.000	1.575579	2.15683
__000007_t	.0022	.0055947	0.39	0.694	-.0087654	.0131654
_cons	5.555305	3.760164	1.48	0.140	-1.814481	12.92509
Group 6						
lncapital	1.299907	.306643	4.24	0.000	.6988977	1.900916
lnlabour	.0060346	.1641113	0.04	0.971	-.3156175	.3276868
underval	.07647	.0237959	3.21	0.001	.0298308	.1231091
__00000R_c	1.334019	.1151589	11.58	0.000	1.108311	1.559726
__000007_t	-.0125991	.0023628	-5.33	0.000	-.01723	-.0079682
_cons	-2.218976	.954077	-2.33	0.020	-4.088932	-.3490192

COMMON CORRELATED EFFECTS

Group-specific coefficients

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Group 1						
lncapital	-.197589	.2105131	-0.94	0.348	-.6101871	.2150091
lnlabour	-.2009181	.048786	-4.12	0.000	-.2965369	-.1052993
underval	.1475189	.0505911	2.92	0.004	.0483621	.2466756
__00000M_l~t	.147112	.1347996	1.09	0.275	-.1170903	.4113143
__00000L_l~l	-.3733283	.6088584	-0.61	0.540	-1.566669	.8200121
__00000L_l~r	.3004818	.2554084	1.18	0.239	-.2001094	.801073
__00000L_u~l	0	.	.	.	.	.
_cons	7.228743	2.288679	3.16	0.002	2.743014	11.71447
Group 2						
lncapital	.4496812	.1035046	4.34	0.000	.2468159	.6525466
lnlabour	.1857976	.2846997	0.65	0.514	-.3722035	.7437987
underval	-.0413479	.0385555	-1.07	0.284	-.1169154	.0342195
__00000M_l~t	1.285549	.0832184	15.45	0.000	1.122444	1.448654
__00000L_l~l	-.8989397	.3458824	-2.60	0.009	-1.576857	-.2210226
__00000L_l~r	-.0995217	.3788861	-0.26	0.793	-.8421248	.6430813
__00000L_u~l	0	.	.	.	.	.
_cons	.8476485	2.091561	0.41	0.685	-3.251736	4.947033

Group 3						
lncapital	-1.007204	.4766647	-2.11	0.035	-1.94145	-.0729587
lnlabour	-.2688551	.1113568	-2.41	0.016	-.4871104	-.0505998
underval	-.1819856	.0713648	-2.55	0.011	-.321858	-.0421131
__00000M_1~t	.4269775	.1112111	3.84	0.000	.2090077	.6449473
__00000L_1~l	.9919107	.4257216	2.33	0.020	.1575116	1.82631
__00000L_1~r	.7042516	.3760966	1.87	0.061	-.0328843	1.441387
__00000L_u~l	0	.	.	.	.	.
_cons	-.2207376	3.960334	-0.06	0.956	-7.98285	7.541375
Group 4						
lncapital	1.294648	.3040523	4.26	0.000	.6987167	1.89058
lnlabour	-.0494204	.1113707	-0.44	0.657	-.267703	.1688623
underval	-.0752304	.0318347	-2.36	0.018	-.1376252	-.0128356
__00000M_1~t	.8716156	.1232101	7.07	0.000	.6301282	1.113103
__00000L_1~l	-1.328625	.2957009	-4.49	0.000	-1.908188	-.7490622
__00000L_1~r	.0890631	.2337855	0.38	0.703	-.369148	.5472742
__00000L_u~l	0	.	.	.	.	.
_cons	1.273833	1.434648	0.89	0.375	-1.538027	4.085692

Group 5						
lncapital	1.151674	1.323008	0.87	0.384	-1.441375	3.744723
lnlabour	-.0631164	.0455918	-1.38	0.166	-.1524747	.0262419
underval	-.0482569	.0509928	-0.95	0.344	-.148201	.0516872
__00000M_1~t	1.721059	.2320148	7.42	0.000	1.266318	2.1758
__00000L_1~l	-.9464343	1.204818	-0.79	0.432	-3.307834	1.414965
__00000L_1~r	-.4442375	.2724571	-1.63	0.103	-.9782437	.0897686
__00000L_u~l	0	.	.	.	.	.
_cons	-2.589953	1.89815	-1.36	0.172	-6.310258	1.130353
Group 6						
lncapital	.4922986	.3910844	1.26	0.208	-.2742128	1.25881
lnlabour	.8334229	.1551614	5.37	0.000	.5293121	1.137534
underval	.1101818	.0331224	3.33	0.001	.0452631	.1751005
__00000M_1~t	.9419709	.1147371	8.21	0.000	.7170904	1.166851
__00000L_1~l	-1.288292	.6666282	-1.93	0.053	-2.594859	.0182752
__00000L_1~r	-.2475941	.1859908	-1.33	0.183	-.6121293	.1169411
__00000L_u~l	0	.	.	.	.	.
_cons	.9465704	1.485996	0.64	0.524	-1.965929	3.85907

APPENDIX J: TIME SERIES EVIDENCE

MINING SECTOR

ARDL Bounds Test
Date: 09/06/16 Time: 17:38
Sample: 1986 2014
Included observations: 29
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.498729	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Cointegrating And Long Run Form
Dependent Variable: LOG(OUTPUT)
Selected Model: ARDL(1, 0, 1, 1)
Date: 09/06/16 Time: 17:38
Sample: 1985 2014
Included observations: 29

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LABOUR)	0.133062	0.039852	3.338857	0.0030
DLOG(CAPITAL)	0.576141	0.224299	2.568629	0.0175
D(UNDERVAL)	0.284934	0.099269	2.870319	0.0089
CointEq(-1)	-0.494390	0.157838	-3.132258	0.0048

CointEq = LOG(OUTPUT) - (-0.2691*LOG(LABOUR) + 0.0714
*LOG(CAPITAL) + 1.0685*UNDERVAL + 15.4990)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LABOUR)	0.269143	0.058803	4.577003	0.0001
LOG(CAPITAL)	0.071445	0.085222	0.838340	0.4109
UNDERVAL	1.068548	0.404046	2.644621	0.0148
C	15.498967	1.641711	9.440739	0.0000

Ramsey RESET Test
Equation: UNTITLED
Specification: D(LOG(OUTPUT)) D(LOG(OUTPUT(-1))) D(LOG(LABOUR))
D(LOG(CAPITAL)) D(UNDERVAL) C
Omitted Variables: Squares of fitted values

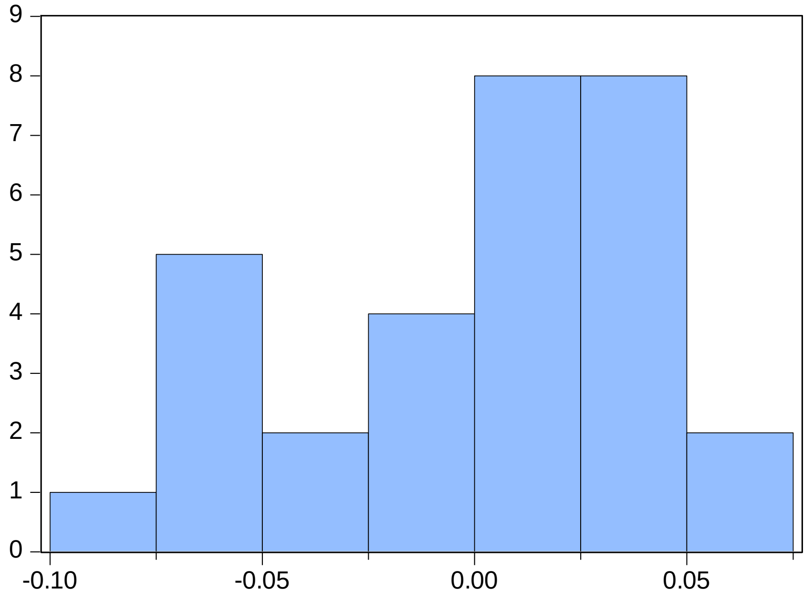
	Value	df	Probability
t-statistic	0.165082	22	0.8704
F-statistic	0.027252	(1, 22)	0.8704
Likelihood ratio	0.034663	1	0.8523

Breusch-Godfrey Serial Correlation LM Test:

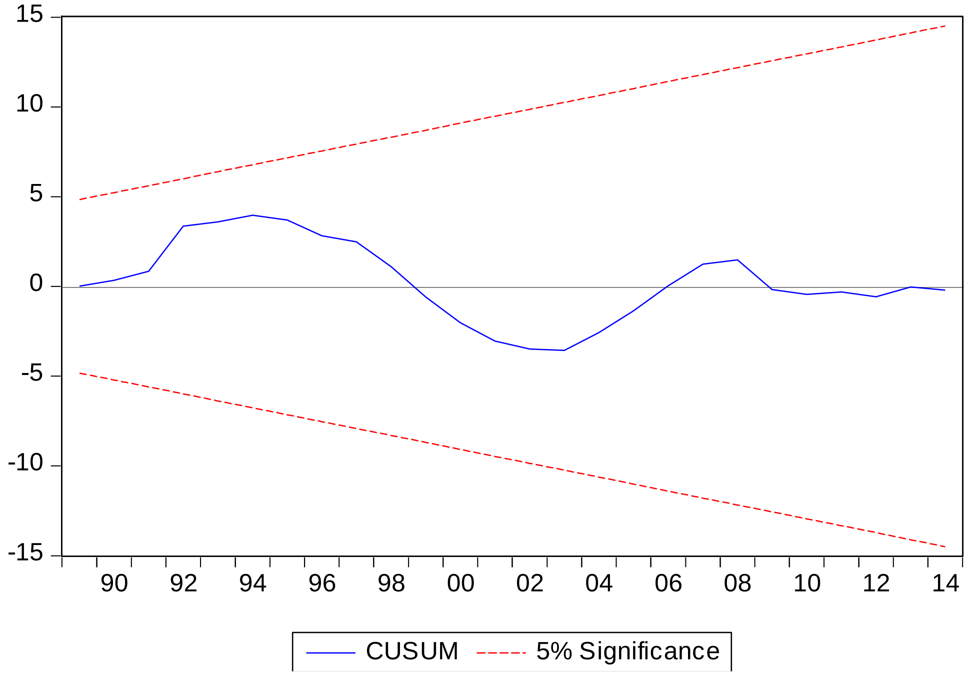
F-statistic	2.797455	Prob. F(2,21)	0.0837
Obs*R-squared	5.890506	Prob. Chi-Square(2)	0.0526

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.063064	Prob. F(4,23)	0.3972
Obs*R-squared	4.368930	Prob. Chi-Square(4)	0.3584
Scaled explained SS	8.011531	Prob. Chi-Square(4)	0.0912



Series: Residuals	
Sample 1985 2014	
Observations 30	
Mean	-8.28e-16
Median	0.008047
Maximum	0.063167
Minimum	-0.098421
Std. Dev.	0.041357
Skewness	-0.577514
Kurtosis	2.385447
Jarque-Bera	2.139703
Probability	0.343059



MANUFACTURING SECTOR

ARDL Bounds Test
Date: 09/06/16   Time: 17:59
Sample: 1989 2014
Included observations: 26
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.751259	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Cointegrating And Long Run Form
Dependent Variable: LOG(OUTPUT)
Selected Model: ARDL(1, 0, 2, 0)
Date: 09/06/16 Time: 18:04
Sample: 1985 2014
Included observations: 28

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LABOUR)	0.124255	0.157766	0.787595	0.4397
DLOG(CAPITAL)	1.321059	0.298607	4.424079	0.0002
DLOG(CAPITAL(-1))	-1.794455	0.193754	-9.261520	0.0000
D(UNDERVAL)	-0.323699	0.100396	-3.224222	0.0041
CointEq(-1)	-0.154296	0.050896	-3.031573	0.0063

CointEq = LOG(OUTPUT) - (0.8053*LOG(LABOUR) + 2.8330*LOG(CAPITAL)
-2.0979*UNDERVAL -34.9903)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LABOUR)	0.805308	1.185000	0.679585	0.5042
LOG(CAPITAL)	2.832956	0.706910	4.007522	0.0006
UNDERVAL	-2.097912	0.440089	-4.767021	0.0001
C	-34.990267	25.988648	-1.346367	0.1925

Ramsey RESET Test
Equation: UNTITLED
Specification: LOG(OUTPUT) LOG(OUTPUT(-1)) LOG(LABOUR)
LOG(CAPITAL) LOG(CAPITAL(-1)) LOG(CAPITAL(-2)) UNDERVAL C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.836222	20	0.4129
F-statistic	0.699267	(1, 20)	0.4129

F-test summary:

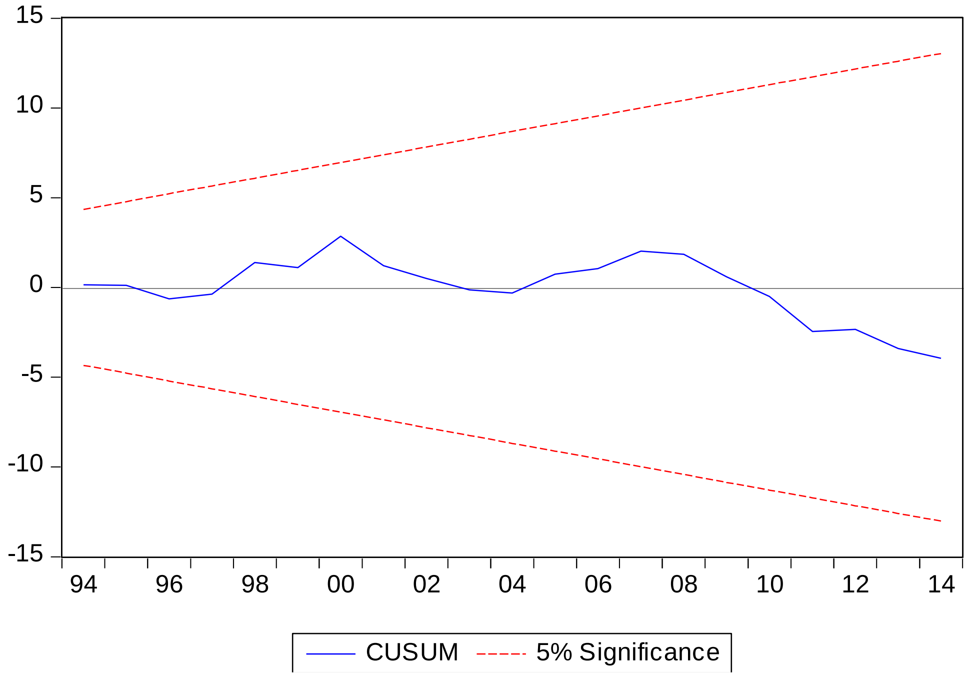
	Sum of Sq.	df	Mean Squares
Test SSR	0.000419	1	0.000419
Restricted SSR	0.012402	21	0.000591
Unrestricted SSR	0.011983	20	0.000599

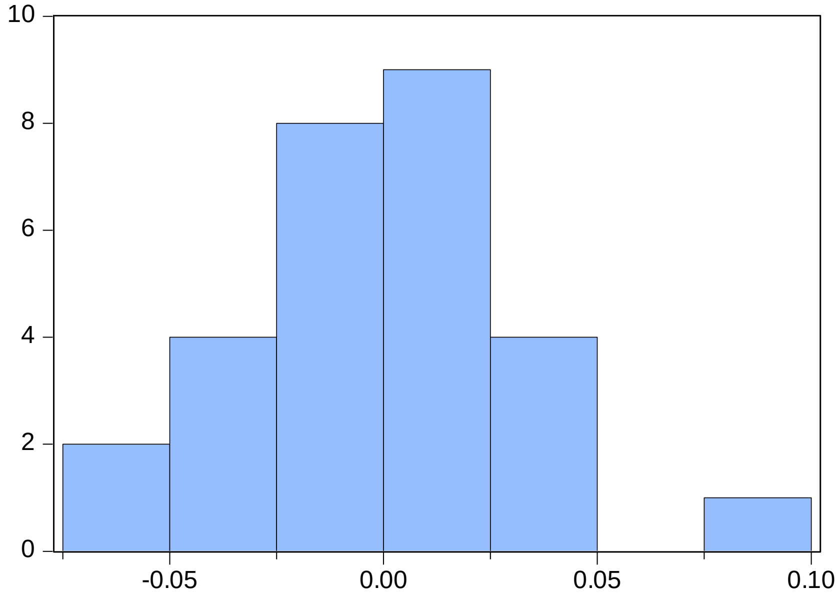
Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.096993	Prob. F(2,19)	0.9080
Obs*R-squared	0.282985	Prob. Chi-Square(2)	0.8681

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.762873	Prob. F(6,21)	0.6070
Obs*R-squared	5.010811	Prob. Chi-Square(6)	0.5424
Scaled explained SS	5.956216	Prob. Chi-Square(6)	0.4281





Series: Residuals
Sample 1987 2014
Observations 28

Mean	2.48e-19
Median	0.000273
Maximum	0.095646
Minimum	-0.068130
Std. Dev.	0.032588
Skewness	0.395762
Kurtosis	4.356230
Jarque-Bera	2.876850
Probability	0.237301

AGRICULTURE SECTOR

ARDL Bounds Test
Date: 09/06/16 Time: 18:21
Sample: 1987 2014
Included observations: 28
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	16.20811	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Cointegrating And Long Run Form
Dependent Variable: LOG(OUTPUT)
Selected Model: ARDL(1, 1, 0, 0)
Date: 09/06/16 Time: 20:50
Sample: 1985 2014
Included observations: 28

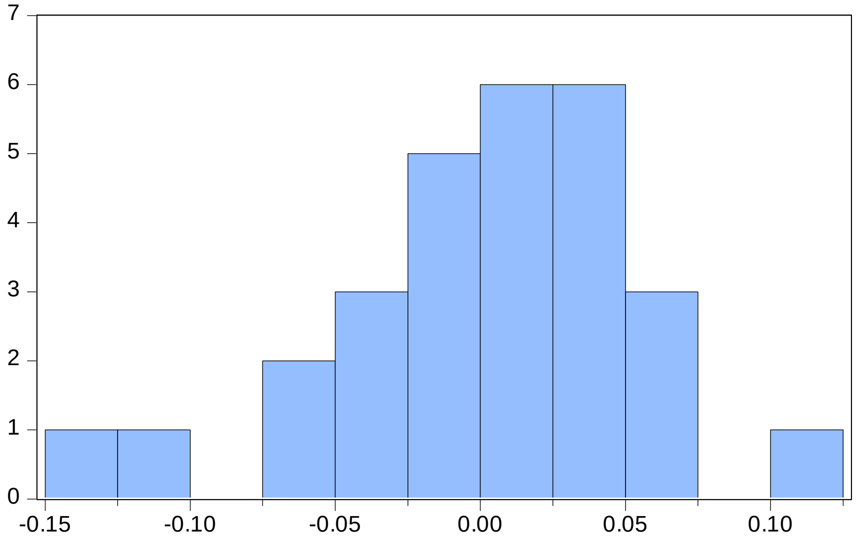
Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LABOUR)	-0.302575	0.120171	-2.517865	0.0196
DLOG(CAPITAL)	0.434177	0.286739	1.514190	0.1442
D(UNDERVAL)	-0.599142	0.252928	-2.368826	0.0270
CointEq(-1)	-0.401865	0.104298	-3.853053	0.0001

Cointeq = LOG(OUTPUT) - (0.0046*LOG(LABOUR) + 0.3005
*LOG(CAPITAL) -0.4147*UNDERVAL -3.8102)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LABOUR)	0.004565	0.012330	0.370200	0.7148
LOG(CAPITAL)	0.300500	0.199699	1.504765	0.1466
UNDERVAL	-0.414674	0.168266	-2.464399	0.0220
C	-3.810173	2.477539	-1.537886	0.1383



Series: Residuals	
Sample 1987 2014	
Observations 28	
Mean	8.88e-16
Median	0.008564
Maximum	0.115820
Minimum	-0.141642
Std. Dev.	0.052843
Skewness	-0.579767
Kurtosis	3.890935
Jarque-Bera	2.494663
Probability	0.287270

Ramsey RESET Test
Equation: UNTITLED
Specification: (LOG(OUTPUT)) LOG(OUTPUT(-1)) LOG(LABOUR) LOG(CAPITAL) LOG(CAPITAL(-1)) UNDERVAL UNDERVAL(-1) UNDERVAL(-2) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.893486	19	0.3828
F-statistic	0.798317	(1, 19)	0.3828

F-test summary:

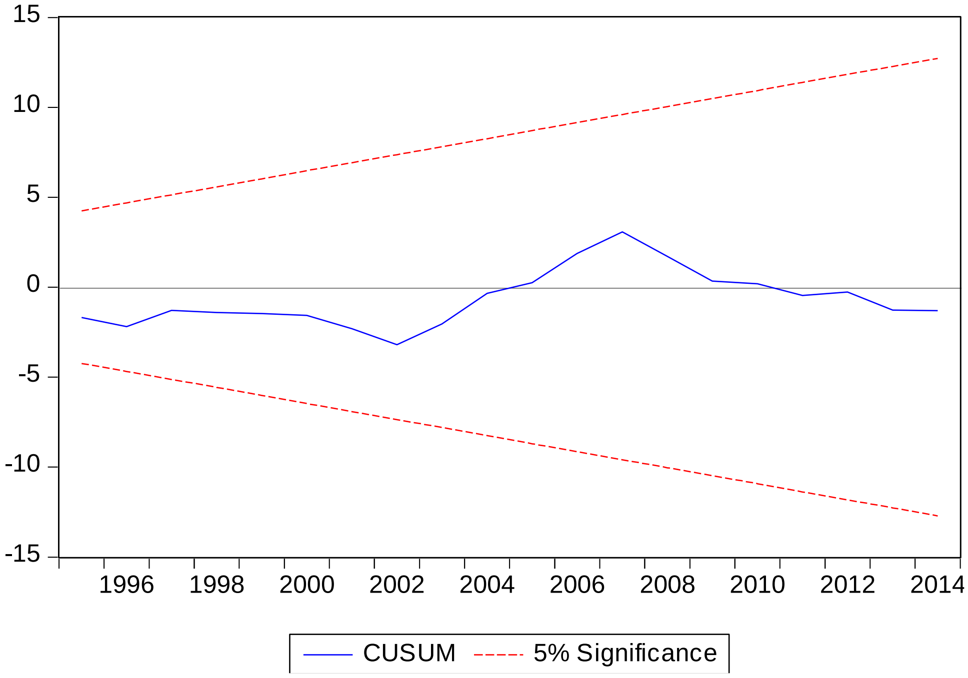
	Sum of Sq.	df	Mean Squares
Test SSR	0.003008	1	0.003008
Restricted SSR	0.074610	20	0.003730
Unrestricted SSR	0.071601	19	0.003768

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.085898	Prob. F(2,18)	0.9181
Obs*R-squared	0.264713	Prob. Chi-Square(2)	0.8760

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.545448	Prob. F(7,20)	0.7901
Obs*R-squared	4.488503	Prob. Chi-Square(7)	0.7221
Scaled explained SS	3.567935	Prob. Chi-Square(7)	0.8280



TOURISM SECTOR

ARDL Cointegrating And Long Run Form
Dependent Variable: LOG(OUTPUT)
Date: 09/07/16 Time: 15:36
Sample: 1985 2014
Included observations: 25

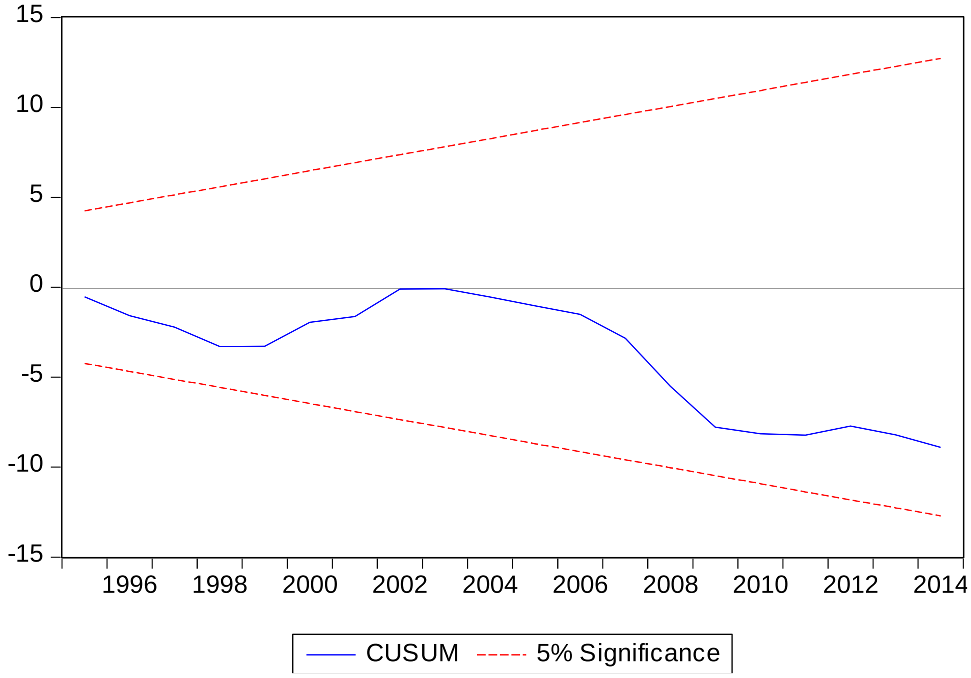
Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LABOUR)	-0.083106	0.106323	-0.781642	0.4545
DLOG(LABOUR(-1))	-0.120742	0.083703	-1.442502	0.1830
DLOG(LABOUR(-2))	-0.143893	0.060110	-2.393831	0.0403
DLOG(CAPITAL)	5.933050	0.510982	11.611076	0.0000
DLOG(CAPITAL(-1))	6.578365	1.993229	3.300357	0.0092
DLOG(CAPITAL(-2))	-4.678202	0.739721	-6.324278	0.0001
D(UNDERVAL(-1))	0.824440	0.131043	6.291386	0.0001
CointEq(-1)	-0.906423	0.172199	-5.263814	0.0005

Cointeq = LOG(OUTPUT) - (0.1699*LOG(LABOUR) + 1.7358*LOG(CAPITAL)
-2.9766*UNDERVAL -10.8516)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LABOUR)	0.169855	0.207210	0.819723	0.4335
LOG(CAPITAL)	1.735834	0.159528	10.881060	0.0000
UNDERVAL	-2.976644	0.470020	-6.333017	0.0001
C	-10.851556	1.145317	-9.474718	0.0000



ARDL Bounds Test
Date: 09/07/16 Time: 15:36
Sample: 1990 2014
Included observations: 25
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	17.90610	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Ramsey RESET Test
Equation: UNTITLED
Specification: (LOG(OUTPUT)) LOG(OUTPUT(-1)) LOG(LABOUR)
LOG(LABOUR(-1)) LOG(LABOUR(-2)) LOG(LABOUR(-3))
LOG(CAPITAL) LOG(CAPITAL(-1)) LOG(CAPITAL(-2)) LOG(CAPITAL(
-3)) UNDERVAL UNDERVAL(-1) UNDERVAL(-2) UNDERVAL(-3)
UNDERVAL(-4) UNDERVAL(-5) C
Omitted Variables: Squares of fitted values

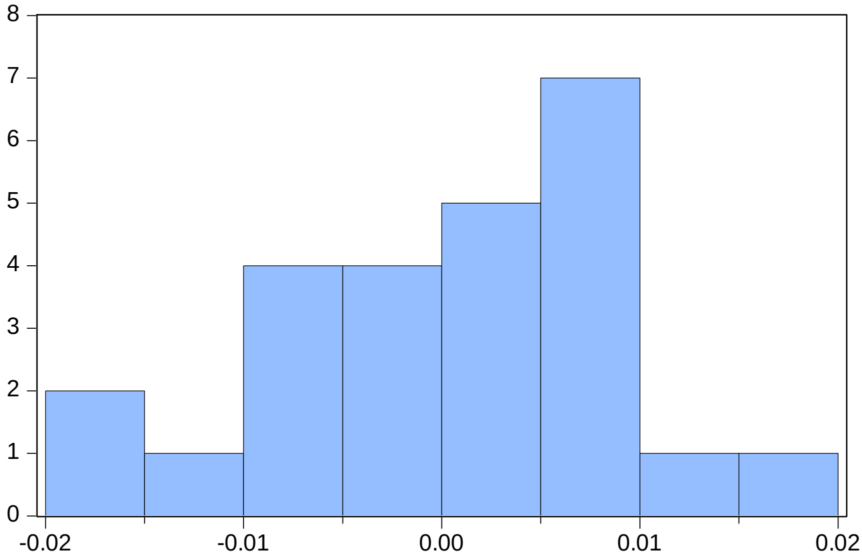
	Value	df	Probability
t-statistic	0.539167	8	0.6044
F-statistic	0.290702	(1, 8)	0.6044

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.310716	Prob. F(15,9)	0.9778
Obs*R-squared	8.529443	Prob. Chi-Square(15)	0.9008
Scaled explained SS	0.999170	Prob. Chi-Square(15)	1.0000

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.987620	Prob. F(2,7)	0.4190
Obs*R-squared	5.501914	Prob. Chi-Square(2)	0.0639



Series: Residuals
Sample 1990 2014
Observations 25

Mean	-9.95e-16
Median	0.000550
Maximum	0.015380
Minimum	-0.019620
Std. Dev.	0.008755
Skewness	-0.510117
Kurtosis	2.807773
Jarque-Bera	1.122740
Probability	0.570427

FINANCIAL SECTOR

ARDL Bounds Test
Date: 09/07/16 Time: 15:56
Sample: 1987 2014
Included observations: 28
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	8.789666	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Cointegrating And Long Run Form
Dependent Variable: LOG(OUTPUT)
Selected Model: ARDL(1, 0, 0, 4)
Date: 09/07/16 Time: 16:14
Sample: 1985 2014
Included observations: 24

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LABOUR(-1))	0.446992	0.115308	3.876517	0.0015
DLOG(CAPITAL(-1))	1.126084	0.546441	2.060761	0.0571
D(UNDERVAL(-1))	0.815660	0.302586	2.695632	0.0166
CointEq(-1)	-0.643243	0.175892	-3.657025	0.0023

Cointeq = LOG(OUTPUT) - (0.6949*LOG(LABOUR(-1)) + 1.7506
*LOG(CAPITAL(-1)) -2.6079*UNDERVAL(-2) -21.9047)

Long Run Coefficients

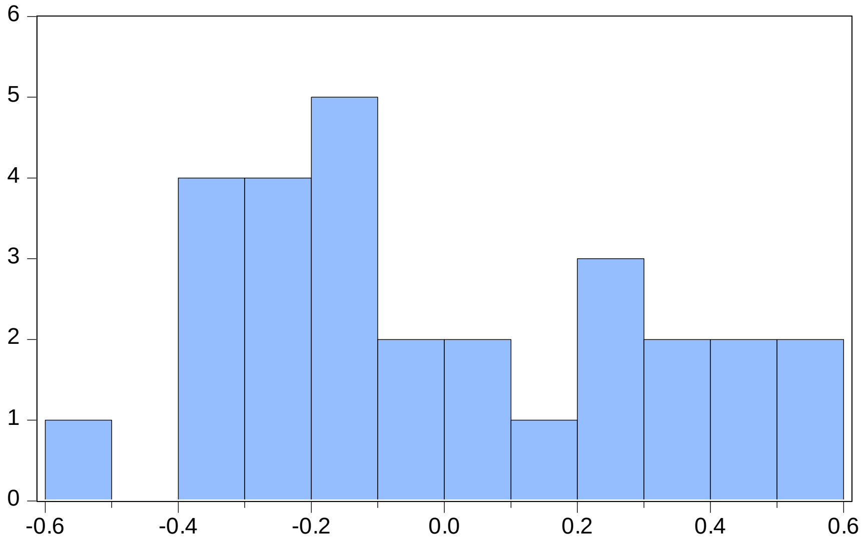
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LABOUR)	0.694903	0.181251	3.833937	0.0016
LOG(CAPITAL)	1.750636	0.494290	3.541722	0.0030
UNDERVAL	-2.607921	1.048151	-2.488116	0.0251
C	-21.904655	4.684269	-4.676216	0.0003

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.620368	14	0.5450
F-statistic	0.384856	(1, 14)	0.5450

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000777	1	0.000777
Restricted SSR	0.029042	15	0.001936
Unrestricted SSR	0.028265	14	0.002019



Series: Residuals
Sample 1987 2014
Observations 28

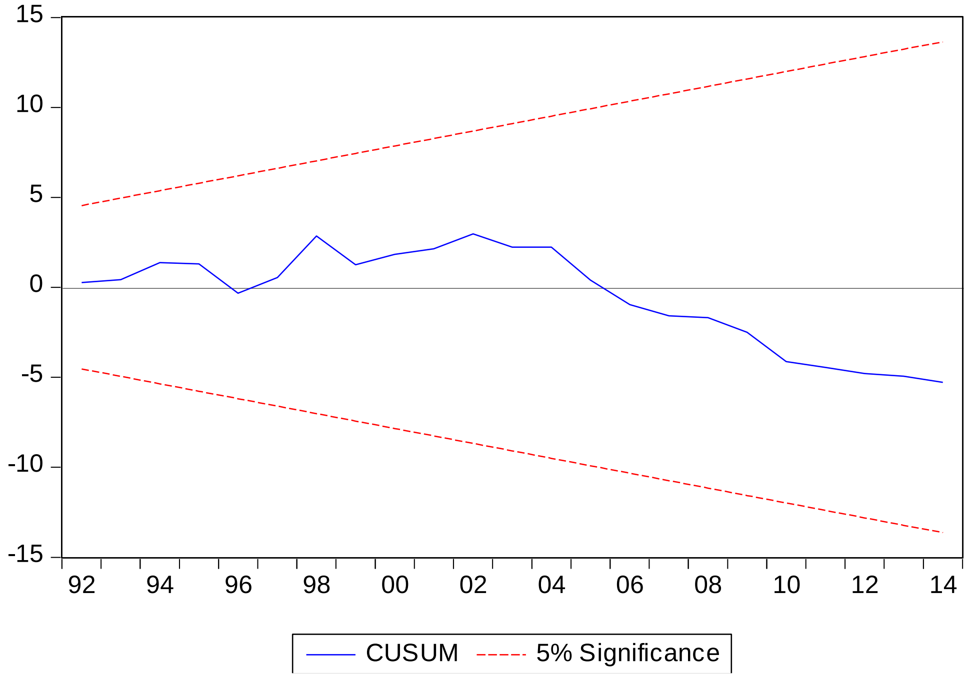
Mean	-4.44e-15
Median	-0.088637
Maximum	0.542082
Minimum	-0.500221
Std. Dev.	0.308664
Skewness	0.331468
Kurtosis	1.829698
Jarque-Bera	2.110605
Probability	0.348087

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.794307	Prob. F(2,13)	0.4727
Obs*R-squared	2.613459	Prob. Chi-Square(2)	0.2707

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.385856	Prob. F(8,15)	0.9117
Obs*R-squared	4.096038	Prob. Chi-Square(8)	0.8484
Scaled explained SS	7.576863	Prob. Chi-Square(8)	0.4759



COMMUNITY SECTOR

ARDL Cointegrating And Long Run Form
Dependent Variable: D(LOG(OUTPUT))
Date: 09/07/16 Time: 16:35
Sample: 1985 2014
Included observations: 26

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LABOUR)	0.378357	0.138290	2.735962	0.0170
DLOG(LABOUR(-1))	-0.456607	0.192161	-2.376165	0.0335
DLOG(LABOUR(-2))	0.049232	0.171000	0.287906	0.7780
DLOG(LABOUR(-3))	0.231473	0.123789	1.869909	0.0842
DLOG(CAPITAL)	0.390708	0.134900	2.896284	0.0125
D(UNDERVAL(-1))	0.323259	0.066681	4.847833	0.0003
CointEq(-1)	-0.911546	0.153054	-5.955727	0.0000

CointEq = D(LOG(OUTPUT)) - (-0.4208*LOG(LABOUR) + 0.4286
*LOG(CAPITAL) -0.8581*UNDERVAL + 0.3383)

Long Run Coefficients

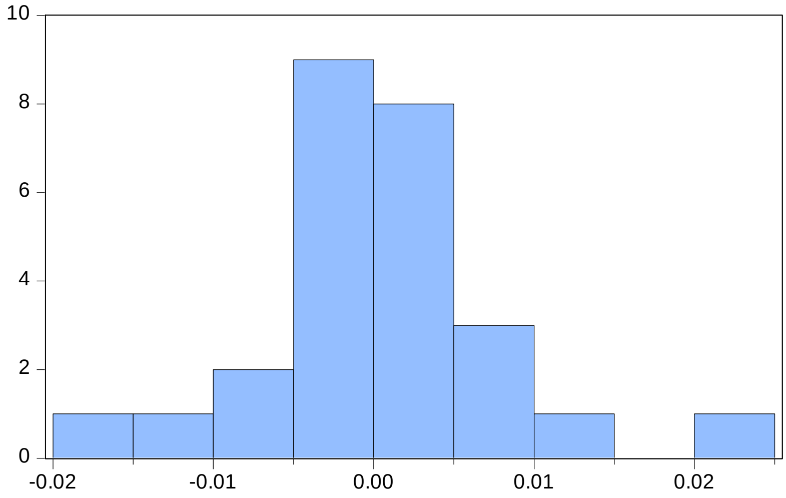
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LABOUR)	-0.420849	0.158392	-2.657007	0.0197
LOG(CAPITAL)	0.428622	0.145993	2.935912	0.0116
UNDERVAL	-0.858115	0.147044	-5.835748	0.0001
C	0.338252	0.616226	0.548909	0.5924

ARDL Bounds Test
Date: 09/07/16 Time: 16:37
Sample: 1989 2014
Included observations: 26
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	10.75500	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61



Series: Residuals	
Sample 1989 2014	
Observations 26	
Mean	-2.17e-15
Median	-0.000488
Maximum	0.020010
Minimum	-0.019460
Std. Dev.	0.007812
Skewness	-0.006917
Kurtosis	4.146741
Jarque-Bera	1.424806
Probability	0.490464

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	5.573595	Prob. F(2,11)	0.0213
Obs*R-squared	13.08640	Prob. Chi-Square(2)	0.0014

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.934713	Prob. F(12,13)	0.5435
Obs*R-squared	12.04261	Prob. Chi-Square(12)	0.4423
Scaled explained SS	4.736871	Prob. Chi-Square(12)	0.9662

Ramsey RESET Test
Equation: UNTITLED

	Value	df	Probability
t-statistic	1.105433	12	0.2906
F-statistic	1.221982	(1, 12)	0.2906