THE NATURAL RATE OF GROWTH, THE BALANCE OF PAYMENTS CONSTRAINED GROWTH MODEL AND STRUCTURAL CHANGE: THE CASE OF SUB-SAHARAN AFRICA

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DECLARATION

I certify that this work has not been accepted in substance for any degree, and is not concurrently being submitted for any degree other than that of Doctor of Philosophy being studied at the University of Greenwich. I also declare that this work is the result of my own investigations except where otherwise identified by references and that I have not plagiarised another's work.

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ABSTRACT

The research aims to answer questions related to the relevance of aggregate demand and the balance of payments constraint for low income countries, with specific reference to the sub-Saharan African region. We empirically test if the natural rate of growth is endogenous to the actual rate of growth. The results across different estimation techniques provide robust evidence that the natural rate of growth is endogenous to demand changes. Applying a political economy and institutionalist approach to the post-Keynesian theory, we show that the responsiveness in the natural rate of growth to demand changes is most sensitive for low income economies and negatively correlated with key institutional indicators.

The above results motivate the application of a demand-led growth model. In the post-Keynesian literature, the main constraint to growth in an open economy is the balance of payments equilibrium growth rate. We therefore empirically test the latter for 22 countries for the 1960 to 2014 period. The results provide strong support that the sub-Saharan region was balance of payments constrained.

In the long run growth in potential output should equal growth in demand, hence we analyse the long run relationship between the natural rate of growth and the balance of payments constrained growth rate using a 4 year average. The results show that within limits, supply adjusts to demand. The results provide further support that the main constraint to long run growth is the balance of payments equilibrium growth rate.

In light of our findings, long run growth can be raised by increasing the income elasticity of demand for exports and decreasing the income elasticity of demand for imports. The respective elasticities of demand are determined by the structure of economic activity. Closer regional integration can help alleviate the demand constraint and facilitate structural transformation along Kaldorian lines for sustainable growth and development.

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Chapter 1

1. INTRODUCTION

Neoclassical economics and international trade theory based on static comparative advantage has dominated economic policies in the sub-Saharan African region. The emphasis has been on trade and financial liberalisation for the efficient allocation of resources, leading to specialisation in the production of products with a “natural or artificial” comparative advantage. Strongly favoured and pursued by the major international financial institutions like the World Bank and the International Monetary Fund (IMF), these policies were imposed on developing countries seeking financial assistance from the latter through loan conditionality and structural adjustment programs (International Monetary Fund, 2016).

When measured against key development indicators, economic performance in sub-Saharan Africa has been poor compared to other world regions. In addition, sub-Saharan Africa is the only world region that has failed to significantly reduce the level of poverty. Between the 1981 to 2008 period, poverty levels remained persistently high at over 69%, measured at United States Dollars (USD) 2 a day poverty line. There is empirical evidence that structural adjustment programs lead to increased inequality (Crisp and Kelly, 1999; Easterly, 2003) and reduce the extent to which the poor share in economic growth (Easterly, 2003).

Liberalisation policies based on static comparative advantage has left the region heavily dependent on the production and export of primary products. It is well known in the heterodox economic literature that over time, the terms of trade move against primary products in favour of manufactured products (Prebisch, 1950; Singer, 1950). Applying data from the 1650 to 2005 period, Arezki et al (2013) provide evidence in support of a downward circular trend in relative commodity prices, thus providing support for the Prebisch-Singer hypothesis. In addition, Easterly (2003) shows that such policies leave developing countries more vulnerable to external fluctuations and crisis.

Failure of liberalisation policies has been placed on poor governance and institutions (World Bank, 1992) aiding in the popularity of the institutionalist approach to economic growth. Many heterodox economic schools, particularly Latin American Structuralism, the post-Keynesians, the big push and balanced/unbalanced growth advocates maintain that more is needed to bring about economic development, emphasising the role of planned state led industrialisation. Indeed, neoclassical and international trade models based on comparative advantage are criticised for being sector indifferent, in the sense that there is no special role for industrial activities or the manufacturing sector in development. This is in contrast to post-Keynesian economics which identify the latter as the engine for long run sustainable growth due to increasing returns to scale (Kaldor, 1966).

Mainstream economists argued that Keynesian economics is irrelevant for developing countries (Dasgupta, 1954). However post-Keynesian economics indicate that there are several ways in which aggregate demand is relevant for the growth process of less developed countries even in the presence of supply constraints such as, “capital shortages, stagnant agricultural sectors and foreign exchange availability” (Dutt, 1996). Post-Keynesian economists have demonstrated that if the natural rate of growth, which is the maximum growth rate a country can achieve under the assumption of full employment, is endogenous to the actual rate of growth, demand matters for economic growth and development (Leon-Ledesma and Thirlwall, 2002).

In most cases, the actual rate of growth is demand constrained as demand constraints come into effect before supply constraints are reached (Thirlwall, 2013). In the post-Keynesian literature, the main constraint to long run growth in an open economy is the balance of payments equilibrium growth rate (Thirlwall, 2001). This is the growth rate consistent with equilibrium on the current account of the balance of payments, under the assumption that a current account deficit cannot be financed indefinitely and debt “ultimately” needs to be repaid (Thirlwall, 1979; 2001).

The endogeneity hypothesis for the natural rate of growth has been applied to several middle and high income countries, all providing evidence in support for it (Libanio, 2009; Vogel, 2009; Dray and Thirlwall, 2011; Lanzafame, 2014). No studies have been carried out on low income countries or for the sub-Saharan African region.

The research aims to answer the questions related to the relevance of aggregate demand and the balance of payments constraint for low income countries, with specific reference to sub-Saharan Africa. We identify four research sub-questions. *The first is to determine the significance of demand for long run growth.* This is done by estimating the natural rate of growth and testing if it is endogenous to demand shocks.

While the literature distinguishes between advanced economies and developing economies (Dray and Thirlwall, 2011), very little is known about the variability in the responsiveness of the natural rate of growth to changes in demand for developing countries which are made up of a diverse range of economies. We therefore aim to make a further contribution to the literature by distinguishing between low income, lower middle income and upper middle income economies. The mechanisms through which the natural rate of growth responds to demand are identified by applying a political economy and institutionalist approach to the post-Keynesian theory.

Evidence in support of the endogeneity of the natural rate of growth implies the appropriate application of a demand-led growth model. We therefore empirically test the balance of payments constrained growth model (Thirlwall, 1979).

There are several extensions to the model, but very little empirical applications to sub-Saharan Africa. Of the two comprehensive studies identified in the literature, Hussain (1999) applied the balance of payments constrained growth model with capital flows and the terms of trade movements while Perraton (2003) applied the strong version of Thirlwall's law with the terms of trade movements. Both studies provide support for the model with data covering the period from 1970 to mid-1990s. No studies on the region have been done in recent years nor has the extended model which accounts for sustainable debt accumulation and interest payments abroad been tested. Debt accumulation and interest payments abroad are expected to have a significant role in the region, as 33 of the 39 countries described as heavily indebted poor countries are in sub-Saharan Africa (World Bank, 2015).

Our second research sub-question is to determine if the balance of payments constrained growth model is still relevant for the region as well as to identify which model specification best describes the growth experience of the respective countries.

This is addressed by empirically testing six different variations of the balance of payments constraint growth model including the original version (Thirlwall, 1979) and the extended model with sustainable debt accumulation, interest payments abroad and the terms of trade movements (Moreno-Brid, 2003).

In the long run, growth in potential output should equal growth in demand or there would be ever increasing excess capacity or ever increasing under capacity utilisation (Palley, 2003). *Hence, our third research sub-question aims at understanding the long run relationship between the natural rate of growth and the balance of payments constrained growth rate*. The adjustment to the steady state is examined using panel Granger causality analysis.

A key consequence of the balance of payments constrained growth model is that the structure of production matters for growth as it determines the respective export and import elasticities of demand. What a country exports has to do with how its economic activity is structured. Differences in the respective elasticities therefore explain growth rate differences between countries. *Hence, our fourth research sub-question relates to how growth enhancing structural change, in light of our findings on the relevance of demand, can be achieved for sustainable growth and development.*

The thesis is organised in eight chapters. The relevant literature is reviewed in chapter 2. The review starts with a critical overview of heterodox growth models, in particular the Keynesian demand-led models with reference to developing countries. This is followed by an assessment of supply-led models that have dominated economic policies in the region. The empirical literature provides evidence that the latter have failed to bring about sustainable growth and development.

The debate surrounding the Harrod (1939) model between neoclassical and neo-Keynesian economics is discussed. Central is the adjustment mechanism that reconciles the natural rate of growth and the warranted rate of growth. Although both treat the natural rate of growth as exogenous, the post-Keynesian literature treats the natural rate of growth as endogenous.

Thirlwall (2001) extended the Harrod (1939) model to an open economy model. Long run growth therefore depends on the relationship between the natural rate of growth, the warranted rate of growth and the balance of payments equilibrium growth rate. The natural rate of growth is treated as endogenous, hence the main constraint to growth is the balance of payments equilibrium growth rate. Empirically testing this relationship for sub-Saharan Africa and low income economies in general would close the gap in the literature as no studies have been carried out on either. It would provide further clarity on the adjustment mechanism that reconciles the respective growth rates for the above mentioned group of countries.

31 sub-Saharan countries are included in our analysis. This consists of a diverse range of countries that have achieved varied growth rates and levels of development. Chapter 3 is therefore a background chapter aimed at providing insight and clarity into the economic structure and growth of the respective countries. Since the early 2000s, sub-Saharan Africa has been one of the fastest growing world regions. However it has not achieved growth enhancing structural transformation. The share of industry in Gross Domestic Product (GDP) dropped from 34.8% in 1981 to 26.4% in 2014. The fall in the latter before a certain level of GDP per capita is reached is identified as “premature deindustrialisation” (Tregenna, 2015).

For the 1974 to 2014 period, five sub-Saharan African countries included in our analysis experienced a current account surplus. These countries were Botswana, Namibia, Angola, Gabon and Nigeria. The rest of the region faced on average a current account deficit. This is an indication that the region was balance of payments constrained during the period concerned. This further motivates the empirical application of the balance of payments constrained growth model.

In chapter 4 we empirically test if the natural rate of growth is endogenous to the actual rate of growth. This sheds light on the importance of demand for economic growth. Time series and panel data estimation techniques are used with data covering the 1991 to 2012 period. The time period is limited due to data availability. Any results obtained from time series analysis are therefore only indicative. Both the time series and panel data analysis provide support for the endogeneity of the natural rate of growth, i.e. the natural rate of growth responds to domestic and foreign demand. Low income economies proved to be most sensitive to demand changes. Applying a political economy and institutionalist approach to the post-Keynesian theory, we show that the effect of demand on growth is further mediated by institutions. The responsiveness of the natural rate of growth to demand changes is negatively correlated with institutional indicators such as voice and accountability, government effectiveness, regulatory quality and the rule of law.

The results on the endogeneity of the natural rate of growth indicate that a demand-led growth model may be applicable for the region.

In chapter 5, we empirically test the long run demand-led balance of payments constrained growth model for the 1960 to 2014 period. Due to uncertainty regarding the stationarity of the variables as a result of structural breaks in the data, we apply an Autoregressive Distributive Lag (ARDL) model to estimate the import and export demand functions. The results provide evidence that the sub-Saharan region was balance of payments constrained during the period concerned. The model with sustainable debt accumulation and interest payments abroad best explained the growth experience of the region.

Chapter 6 examines the long run relationship between the natural rate of growth and the balance of payments constrained growth rate using panel Granger causality analysis. When applying a 4 year average to smooth out short term fluctuations, the results provide strong evidence of unidirectional causality running from the balance of payments constrained growth rate to the natural rate of growth. This provides evidence that in the long run, within limits, it is supply that adjusts to demand. The chapter examines the mechanisms through which the adjustment occurs.

In light of the empirical results on the relevance of demand for long run growth in chapters 4 to 6, chapter 7 explores the ways in which structural transformation can be achieved for sustainable growth and development. As growth in sub-Saharan Africa for the 1960 to 2014 period was balance of payments constrained, growth in the region can be increased by producing goods with a high income elasticity of demand in world markets as well as reducing the income elasticity of demand for imports.

Manufactured products have a higher income elasticity of demand than primary products. The sub-Saharan African region, has a natural comparative advantage in the production of primary products, which in 2008 accounted for over 85% of exports (United Nations Conference on Trade and Development, 2016). The region therefore need to “defy” their comparative advantage by gaining new capabilities in the production of manufactured products. Due to market failures related to fundamental uncertainty and bounded rationality, growth enhancing structural transformation along Kaldorian lines may not automatically occur (Ebireri and Paloni, 2014). The role of the state in facilitating structural transformation is therefore vital. Closer regional integration between sub-Saharan countries would increase the size of the market and thus help to alleviate the demand constraint to growth, for the division of labour, which leads to static, dynamic and macro increasing returns to scale, is limited by the extent of the market.

Chapter 8 is the conclusion, where we summarise our main findings and the limitations of the thesis that could be addressed through future research. Firstly, due to poor data availability, we do not distinguish between the type and quality of employment. In addition, we do not formally account for illicit financial flows. Future research that extends the balance of payments constrained growth rate to formally include the latter would provide further insight on additional constraints to growth.

Chapter 2

2. LITERATURE REVIEW

This chapter presents a critical review of the different growth models that have been proposed with a focus on the two main schools of thought that have dominated economic thinking, i.e. classical/neoclassical supply side growth models and heterodox models, in particular the Keynesian/post-Keynesian demand-led growth models.

The chapter starts with a discussion of demand-led growth models proposed by Keynesian economics. The literature on demand-led growth models is limited for sub-Sahara Africa due to the dominance of neoclassical economics in the region who argued that the continent was supply constrained with demand being irrelevant for long term growth. However, demand-led growth models have been proven to be relevant, even in the presence of supply constraints (Dutt, 1996). This section therefore begins with an assessment of the Harrod-Domar model.

Modern growth theory began with Harrod (1939) who made the static Keynesian (1936) model dynamic. The Harrod (1939) model, introduced three growth rates and showed that there was no mechanism to reconcile them, thus making the moving equilibrium growth rate “highly unstable”. This sparked a debate between Keynesian economics and neoclassical economics. Both agreed that Harrod (1939) was wrong in supposing that the equilibrium growth rate was unstable however they differed in their approach to the adjustment mechanism that reconciled the three growth rates. The Keynesian and post-Keynesian response is given in section 2.1 as well as the neoclassical response to the Harrod (1939) model. A full discussion of neoclassical growth model is given in section 2.2 under supply-led models.

This debate is central to our research question related to the relevance of aggregate demand for low income countries. In the neoclassical response, demand plays no role however it is central to the post-Keynesian adjustment.

The Harrod (1939) model is a closed economy model. In order to fully understand the growth process of developing countries, it is important to apply an open economy model. We therefore discuss the extension of the Harrod (1939) model to an open economy (Thirlwall, 2001). The relative strengths and weaknesses of other post-Keynesian open economy growth models are outlined, in particular the export-led cumulative causation model (Kaldor, 1970) and the balance of payments constrained growth model (Thirlwall, 1979).

We deliberate on other heterodox models that have had a substantial impact on development economics, including Latin American Structuralism, the big push and balanced/unbalanced growth theories.

In section 2.2 we review supply-led models with a focus on the growth models that have been most influential in the sub-Saharan African region. The neoclassical model, the endogenous growth models, the Lewis dual sector model, the Ricardian and Heckscher Ohlin models based on comparative advantage and the new institutionalist models are presented.

2.1. Heterodox and Demand-Led Growth Models

The Keynesian and post-Keynesian growth models are greatly influenced by the ideas of Keynes (1936) outlined in the "General Theory of Employment". It is a model of effective demand characterised by rigid wages and prices.

The Keynesian (1936) model, in summary, follows that aggregate real income is determined by employment so that if employment increases, income increases[1]. The aggregate demand function can be broken down into the portion that is consumed and the portion that is invested. As income rises, so does consumption as the two in general move in the same direction. However as income increases, the public are willing to widen the gap between their income and consumption hence consumption will increase less than income. This is called the communities propensity to consume which is a rather stable function. The equilibrium level of employment, which is the level of employment where there is no inducement to change employment, is thus determined by the community's propensity to consume and current investment. New investment is determined by the physical conditions of supply in the capital goods market, the state of confidence pertaining to prospective sales, physiological attitudes towards liquidity and the quantity of money.

The equilibrium level of employment cannot be greater than full employment although there is no reason, as done in the classical theory, to assume that the equilibrium is equal to full employment. Full employment would be the exceptional case.

This section starts with the dynamic Harrod-Domar model which was the birth of modern growth theory. This is followed by the Keynesian response to the model, both old (Kaldor, 1956) and new (Leon-Ledesma and Thirlwall, 2002) as well as the neoclassical response.

The Harrod (1939) model was extended to an open economy model (Thirlwall, 2001). Other post-Keynesian open economy models are explored including the export-led cumulative causation

[1] Rigid prices and wages hinder the classical adjustment that restores equilibrium in the labour market.

model (Kaldor, 1970) and the balance of payments constrained growth model (Thirlwall, 1979). Other heterodox models such as Latin American Structuralism and big push theories are discussed.

2.1.1. Harrod-Domar Model

Harrod (1939), greatly influenced by Keynes (1936), made the static Keynesian model dynamic. It was developed in order to answer the question of the effect of a continuous increase (decrease) on the equilibrium of one of the components in the system.

Harrod (1939) distinguished between three different growth rates. The first is the geometric growth rate of income or output, G,

$$G = \frac{s}{C} \quad \text{(Equation 2.1)}$$

where s, is the fraction of income saved, S/Y, and, C, is the increment in the capital stock that actually takes place divided by the increment in total output, ΔK/ΔY.

The second is the warranted rate of growth, G_w. This is the moving equilibrium that ensures that plans to invest equal plans to save ($I_p=S_p$). It should be noted that Harrod (1939) did not refer to it as such as it is highly unstable. Planned investment I_p, is given by,

$$I_p = C_r \Delta Y \quad \text{(Equation 2.2)}$$

where C_r, is the required incremental capital output ratio. Planned savings is given by,

$$S_p = sY \quad \text{(Equation 2.3)}$$

For the moving equilibrium, plans to invest should equal plans to save, hence

$$C_r \Delta Y = sY \quad \text{(Equation 2.4)}$$

or

$$G_w = \frac{s}{C_r} \quad \text{(Equation 2.5)}$$

where C_r, is the volume of capital goods required for the production of a unit increment of output. The warranted rate of growth is therefore an unknown value determined by the propensity to save and the state of technology. It is the rate of growth that leaves all parties satisfied that they have produced the right amount, i.e. there is neither over nor under capacity.

If $C=C_r$, then $G=G_w$, for if plans to invest equal the actual amount invested, then the actual rate of growth equals the warranted rate of growth.

During a period of growth, we are unable to make the assumption that all the individual components in the system are expanding at the same rate. The actual rate of growth will diverge from the warranted rate of growth, "even in the most ideal circumstances conceivable," due to seasonal or random causes (Harrod, 1939, p.16). Any divergence from the warranted rate of growth, either up or down is "unwarranted" and will cause an inducement to depart even further from it. For instance, if G exceeds G_w, the actual increase of capital goods per unit increase of output C, will fall below the desired C_r, resulting in an undue depletion of stock or shortage of equipment stimulating the system to further expansion. Instead of returning to G_w, G will move further from it, and the further it diverges, the greater the stimulus to expansion. If G falls below G_w, there will be a redundancy of capital goods which will exert a depressing influence, causing a further divergence and a still stronger depressing influence.

> *"In the dynamic field we have a condition opposite to that which holds in the static field. A departure from equilibrium instead of being self-righting will be self-aggravating" (Harrod, 1939, p.22).*

There are buffers to this deviation which can be viewed in terms of ceilings and floors (Thirlwall, 2011). We start with the lower buffer, which is reached with the downward movement in the warranted rate of growth given in Equation 2.5[2]. This takes place through a fall in the fraction of income saved, s, or a rise in the capital coefficient, C_r. The latter is unlikely to rise in periods of declining growth, and the former is unlikely to decrease so long as income growth is positive. When growth becomes negative and the level of income recedes, the fraction of income saved decreases and the warranted rate falls. The downward movement is checked (Harrod, 1939).

The upper buffer is given by the natural rate of growth G_n. Assuming full employment, it is defined as the maximum long term rate of growth, allowed for by the increase of population, accumulation of capital, technological change and the work/leisure preference schedule.

$$G_n = l + t \qquad \text{(Equation 2.6)}$$

Where l, is growth of the labour force and t, is labour productivity growth. There is no automatic tendency for the natural rate of growth and the warranted rate of growth to coincide (Harrod, 1939).

The warranted rate of growth that would obtain full employment is the proper warranted rate. If the proper warranted rate is above the natural rate; as the system cannot advance faster than the natural rate, there will be a chronic tendency to depression dragging the warranted rate below its proper warranted rate. This would keep its average value down to the natural rate resulting in

[2] There is no unique warranted rate of growth as it depends on the phase of the trade cycle and the level of activity (Harrod, 1939).

chronic unemployment. The ideal policy therefore would be to maintain equality between the proper warranted rate and the natural rate.

Full employment of labour and capital therefore requires that,

$$G = G_w = G_n \qquad \text{(Equation 2.7)}$$

The relationship between G and G_w relates to the trade cycle and will not further be explored as it is not central to our research question. Long run growth is centred round the relationship between the warranted rate of growth and the natural rate of growth. The adjustment to the endogenous warranted rate of growth to meet the exogenously determined natural rate of growth has sparked a large debate between the neoclassical growth school at Cambridge, Massachusetts and the Keynesian growth school at Cambridge, England (Thirlwall, 2013). While both "camps" take the natural rate of growth as exogenous, there is a third camp who propose that the natural rate of growth is endogenous and adjusts to the actual rate of growth.

2.1.2. The Neoclassical Adjustment to the Harrod-Domar Model

The Solow (1956) model is the neoclassical response to the Harrod (1939) model. A brief discussion of the model is given in this section. The Solow (1956) model has become the basis for supply-led neoclassical models of economic growth. Due to their massive influence on policies related to economic growth, the extended Solow (1956) model with exogenous technological change as well as a summary of the empirical literature is discussed in section 2.2 under supply-led models.

Solow (1956) criticised the Harrod (1939) model for making the crucial assumption of fixed proportions, i.e. in production labour cannot be substituted for capital. Solow (1956) theoretically proved, that once this assumption is abandoned, the "knife-edge notion of unstable balance" vanishes.

The model starts with the assumption of a single commodity, whose rate of production is Y(t), which also represents the communities real income, part of which is consumed, C and the other part saved, S.

$$Y = C + S \qquad \text{(Equation 2.8)}$$

A constant fraction of income is saved, sY(t).

$$S = sY \qquad \text{(Equation 2.9)}$$

Investment is taken as the increase in the net capital stock, after adjusting for depreciation.

$$\dot{K} = sY \qquad \text{(Equation 2.10)}$$

Where $\dot{K}$, is the instantaneous change in the capital stock, Y, is real income and, s, is a constant part of income that is saved. As this is a closed economy, savings equals investment and the only use of investment is to accumulate capital hence, S=I=sY. There is no behavioural investment function.

The capital accumulation equation given in Equation 2.10 is used alongside the production function. The latter represents the technological possibilities using two factors of production, capital, K and labour, L, whose rate of input used to produce output is L(t). As in the Cobb-Douglas production function with constant returns to scale, we assume diminishing returns to each factor of production. The production function is therefore assumed to be homogenous of first degree[3].

$$Y = F(K, L) \qquad \text{(Equation 2.11)}$$

Combining Equation 2.10 and 2.11, gives

$$\dot{K} = sF(K, L) \qquad \text{(Equation 2.12)}$$

The labour force increases at a constant relative rate of n, given by exogenous population growth. In the absence of technological change, n is the natural rate of growth, G_n, described in the Harrod (1939) model[4].

$$L(t) = L_0 e^{nt} \qquad \text{(Equation 2.13)}$$

L in the above equation represents the available supply of labour. L in Equation 2.12 stands for total employment. Full employment is therefore assumed to be continuously maintained.

Equation 2.13 can also be interpreted as the "completely" inelastic labour supply curve, shown graphically as a vertical line which shifts to the right in time as the labour force grows exponentially. The real wage rate adjusts so that all available labour is employed. The marginal productivity equation determines the actual wage rate[5].

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[3] The Cobb-Douglas production function is typically used.

[4] $G_n = l + t$, where, l is growth of the labour force and, t is labour productivity growth. Under the assumption of no technological change, the natural rate of growth is equal to the growth in the labour force, $G_n = l$.

[5] Each unit of labour is paid a wage, w, and each unit of capital used per period is paid a rent, r. Perfect competition is assumed therefore making the firms price takers. The price of output in the economy is normalised to unity so that profit maximising firms aim at, $\max_{K,L} F(K, L) - rK - wL$.

Firms will hire labour until the marginal product of labour is equal to the wage. Likewise firms will rent capital until the marginal product of capital is equal to the rental price. As a result factor payments are equal to output produced and there are no economic profits. Factor payments are also constant over time. Accordingly, $wL + rK = Y$ (Jones, 2002).

We substitute L(t) in Equation 2.12 which gives the only time path, "of capital accumulation that must be followed if all available labour is to be employed" (Solow, 1956, p.67).

$$\dot{K} = sF(K, L_0 e^{nt}) \quad \text{(Equation 2.14)}$$

Once growth in the capital stock and labour force are known, the production function corresponding to the growth of real output can be computed[6]. Adjustment in the real return to factors will bring about full employment of labour and capital. An exact solution however is not possible without studying the exact shape of the production function. Solow (1956) therefore proceeds by isolating certain broad elements.

To do this, the capital labour ratio, r, is introduced,

$$r = \frac{K}{L} \quad \text{(Equation 2.15)}$$

The relative rate of change of r, is equal to the difference between the relative rates of change for capital and labour, which can be shown by first taking logs and then the derivative,

$$\frac{\dot{r}}{r} = \frac{\dot{K}}{K} - \frac{\dot{L}}{L} \quad \text{(Equation 2.16)}$$

where the relative rate of change for labour, $\frac{\dot{L}}{L}$ is the natural rate of growth defined as, n. Substituting, $\frac{\dot{L}}{L}$ with n and $\dot{K}$ with Equation 2.14,

$$\frac{\dot{r}}{r} = \frac{sF(K, L_0 e^{nt})}{K} - n = \frac{sF(K, L)}{K} - n \quad \text{(Equation 2.17)}$$

Hence

$$\dot{r} = r\frac{sF(K, L)}{K} - nr \quad \text{(Equation 2.18)}$$

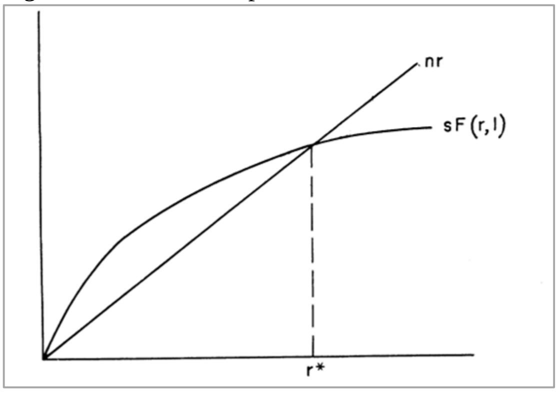
As there are constant returns to scale, we can divide L out of F, so long as we multiply F by the same factor[7], keeping in mind that, L/K=1/r. Hence we end up with,

$$\dot{r} = r\frac{sF(K, L)}{K} - nr = rsF\left(1, \frac{1}{r}\right) - nr = sF(r, 1) - nr \quad \text{(Equation 2.19)}$$

F(r,1) is the total production possibilities curve, showing output per worker as a function of capital per worker. The curve is convex upwards due to diminishing returns to capital. The rate of change

[6] Net capital accumulation, taken as the propensity to save is a constant portion of output. The growth of the labour force is given by the exogenously determined natural rate of growth, n (Solow, 1956).
[7] From Equation 2.13 we know that $L_t = L_0 e^{nt}$.

Figure 2.1; Production possibilities curve



Source: Solow (1956, p.70)

of the capital labour ratio, $\dot{r}$ is the difference of two terms, i.e. the increment in capital and labour respectively.

At the point where the two curves intersect, nr = sF(r,1), $\dot{r} = 0$. The capital labour ratio, r will be constant, as the capital stock is expanding at the same rate as the labour force. Once the capital labour ratio, r* on the figure is established, it will be maintained. Given the assumption of constant returns to scale, output will also grow at the same relative rate, n.

From Equation 2.19 it is clear that if nr<sF(r,1), hence r<r*, r will increase towards r*, a process known as capital deepening. This occurs as investment per worker is greater than that required to keep the capital labour ratio constant. Likewise, if nr>sF(r,1), hence r>r*, r will decrease towards r*, resulting in capital widening. In this case, the growth in the labour force is greater than investment per worker, therefore reducing the capital labour ratio, r. The movement towards the steady state, r*, is the transitional period[8]. The equilibrium value of the capital labour ratio, r* is stable and whatever its initial value, will gravitate towards balanced growth[9] at the natural rate given by n. Hence,

> *"When production takes place under the usual neoclassical conditions of variable proportions and constant returns to scale, no simple opposition between natural and warranted rates of growth is possible. There may not be – in fact in the case of the Cobb-Douglas function there never can be – any knife edge" (Solow, 1956, p.73).*

The model can be interpreted directly using the notation applied in the Harrod (1939) model. Recalling the warranted rate of growth, G_W from the Harrod (1939) model,

$$G_w = \frac{s}{C_r} \qquad \text{(Equation 2.5)}$$

where s, is savings in income and C_r, the required incremental capital output ratio. If the natural rate of growth is higher than the warranted rate of growth, labour is growing faster than capital. Due to changes in the real returns to factors of production, there will be a fall in the price of labour

[8] The rate of economic growth possible in the transitory period essentially depends on the rate of physical capital accumulation. Countries that have high savings/investment rates will therefore tend to be richer, as these countries accumulate more capital per worker, and capital deepening occurs. On the other hand, countries that experience a high population growth rate will tend to be poorer as a fraction of their savings must be spent on maintaining the capital-labour ratio, leading instead to capital widening (Jones, 2002).

[9] Balanced growth is defined as the case where population, capital, output and consumption are growing at constant rates (Jones, 2002).

relative to capital. Producers will move to more labour intensive production techniques. This in turn reduces the incremental capital output ratio, C_r, and the warranted rate of growth will increase, gravitating towards the natural rate of growth. Likewise, if the warranted rate of growth is above the natural rate of growth, capital accumulation would grow faster than the labour force, the relative price of capital to labour would fall and more capital intensive production techniques would be favoured by producers. This would increase C_r, thereby reducing the warranted rate to the natural rate (Thirlwall, 2013).

The adjustment mechanism crucially relies on fully flexible prices. This is in contrast to the Keynesian model where wage and price rigidity prevail. Solow (1956) acknowledges this limitation in the model, stating that such rigidities may be significant in the long run.

2.1.3. The Neo-Keynesian Adjustment to the Harrod-Domar Model

The neo-Keynesian response to reconciling the three growth rates in the Harrod (1939) model focuses on the change in the savings ratio, taken as a function of income distribution between wages and profits. Taking the most basic model (Kaldor, 1956), income, Y, is divided between wages, W and profits, P.

$$Y = W + P \quad \text{(Equation 2.20)}$$

$$S = I \quad \text{(Equation 2.21)}$$

$$S = S_w + S_p \quad \text{(Equation 2.22)}$$

Savings, S, is assumed to be equal to investment, I. The savings function is used to derive the propensities to consume out of profits, s_pP and wages, s_wW, hence S_w= s_wW and S_p= s_pP. The two propensities are assumed to not be equal and the marginal propensity to save out of profits higher than wages, i.e. s_p>s_w. Taking investment as given in Equation 2.21 and substituting the savings propensities.

$$I = s_pP + s_wW = s_pP + s_w(Y - P) = (s_p - s_w)P + s_wY \quad \text{(Equation 2.23)}$$

The investment output ratio I/Y is therefore,

$$\frac{I}{Y} = (s_p - s_w)\frac{P}{Y} + s_w \quad \text{(Equation 2.24)}$$

The profit output ratio, P/Y is,

$$\frac{P}{Y} = \frac{1}{s_p - s_w}\frac{I}{Y} - \frac{s_w}{s_p - s_w} \quad \text{(Equation 2.25)}$$

We assume full employment as, "the state of affairs in which the short-period supply of goods and services in the aggregate is inelastic and irresponsive to further increases in monetary demand" (Kaldor, 1957, p.593). This is of importance as the neo-Keynesians have theoretically shown that the dynamic system cannot operate in a state of Keynesian under-employment equilibrium, a fact overlooked by Harrod (1939). Any level of output below full employment will stimulate expansion until the latter is reached. This occurs as aggregate demand exceeds the aggregate supply price for a given level of output (Kaldor, 1957). The system therefore moves towards a stable equilibrium growth path.

> *"A state of Keynesian under-employment equilibrium, whilst it is perfectly consistent with a static short-period equilibrium, is therefore inconsistent (except by fluke) with a dynamic equilibrium of steady growth" (Kaldor, 1957, p.594).*

Given the respective savings propensities, the share of profits in income, P/Y, in Equation 2.25, depends on the investment to output ratio, I/Y, taken as given by the separate investment function and invariant to the marginal propensities mentioned. The independence of the investment output ratio is described by Kaldor (1956) as the "critical assumption".

In a state of continuous full employment, the actual rate of growth must equal the full employment ceiling, given by growth in the labour force and labour productivity, i.e. $G=G_n$.

The investment output ratio can be restated in terms of the incremental capital output ratio, C and the actual rate of growth, G,

$$\frac{I}{Y} = GC \qquad \text{(Equation 2.26)}$$

In long run equilibrium, S=I, hence we are left with the actual rate of growth given in Equation 2.1

$$G = \frac{s}{C} \qquad \text{(Equation 2.1)}$$

The moving equilibrium warranted rate of growth likewise can be stated in terms of the investment output ratio.

$$\frac{I}{Y} = s \qquad \text{(Equation 2.27)}$$

Substituting s, we get Equation 2.24

$$\frac{I}{Y} = \left(s_p - s_w\right)\frac{P}{Y} + s_w \qquad \text{(Equation 2.24)}$$

Real aggregate supply and demand are therefore aligned, through movements in prices and wages. Thus, if the natural rate of growth is above the warranted rate, plans to invest exceed plans to save, causing a rise in prices and profits. This in turn increases savings as the propensity to consume out of profits is higher and decreases consumption as real wages are decreased.

Similarly, if the warranted rate is above the natural rate, plans to save exceed plans to invest. This has a depressing effect leading to a fall in prices and profits. Consumption is increased and savings reduced.

The two growth rates are therefore not independent of each other. Given flexible profit margins, the warranted rate of growth will adjust to the natural rate of growth through consequential changes in the profit output ratio (Kaldor, 1956).

Kaldor (1957) extended the simple neo-Keynesian adjustment mechanism explained above to include endogenous productivity growth. The model deliberately does not distinguish between changes in productivity resulting from an increased use of capital per worker and changes in productivity due to innovation. Any attempt to separate the two is described as "arbitrary and artificial" (Kaldor, 1957, p.596). The relationship between growth in output and both these factors is treated as a single relationship.

According to Kaldor (1957), for there to be continued growth, it must be supposed that on the one hand, output increases as a result of capital investment. This relationship is captured by the technology progress function which expresses growth in productivity and income as an increasing function of the rate of net investment. On the other hand, investment takes place in response to an increase in output. This relationship is represented by the investment function which shows the latter as a function of changes in output in the previous period and changes in the rate of profit on capital in the period under consideration. The investment function therefore complements the technical progress function (Kaldor, 1957).

Equilibrium long run growth is achieved at the point of intersection between the technology progress function curve and the 45 degree line, where the growth rate of capital and the growth rate of productivity (or output per worker) are equal[10]. Using Harrod's (1939) terminology, Kaldor (1957, p.612) states that the system will, "tend towards an equilibrium rate of growth at which the 'natural' and the 'warranted' rates are equal," any divergence between the two will be eliminated,

[10] In the Kaldor (1957) model, the system will advance at the natural rate of growth. Under the assumption of a constant population, the rate of growth is equal to the growth rate of labour productivity. With population growth, the growth rate is equal to growth in the labour force plus labour productivity growth (Kaldor, 1957).

"partly through an adjustment of the natural rate of growth and partly through an adjustment of the warranted rate".

From the Kaldor (1957) model outlined above, it is clear that growth in output is the major determinant of labour productivity growth (Leon-Ledesma and Thirlwall, 2002). This point is best explained by Verdoorn's law[11].

2.1.4. The Post-Keynesian Adjustment to the Harrod-Domar Model

The neoclassical and the neo-Keynesian adjustment mechanisms outlined above reconcile the warranted and the natural rate of growth. In both approaches, the natural rate of growth, taken as the sum of the labour force growth and productivity growth, is assumed to be exogenously determined. The endogenous warranted rate of growth therefore adjusts to the natural rate of growth. We do make note of the Kaldor (1957) model which treats labour productivity growth as endogenous however growth in the labour force remains exogenously determined.

Leon-Ledesma and Thirlwall (2002) proposed a third adjustment mechanism where the natural rate of growth is endogenous to the system. There are several ways identified in which the natural rate of growth is endogenous to the actual rate of growth.

In explaining the response of labour productivity to growth, the argument is in line with Kaldor (1957; 1966; 1970), that growth in productivity is positively related to growth in output, in particular, growth in the manufacturing sector which is characterised by increasing returns to scale. This is not just due to the static relationship that relates the level of productivity to the scale of output, but the dynamic relationship, which takes technological change into account. During an expansion, the effects of economies of scale due to indivisibilities cannot be separated from the effects of "irreversible" technological change. Faster rates of investment and output therefore lead to faster rates of productivity growth.

> *"Greater division of labour is more productive, partly because it carries with it development of more skills and know how, which in turn lead to more innovations and improvements in design" (Kaldor, 1966, p.13).*

However, economies of scale also result from general industrial expansion, which allows the further division of labour and specialisation of production to take place. These are macro economies of scale which supplant the internal and external economies of individual firms and industries with the more "highly specialised undertakings" resulting from the further division of labour. Industrial operations should therefore be seen as, "an interrelated whole" (Young, 1928,

[11] Although Kaldor (1957) does not directly refer to Verdoorn's law (1949), he did refer to it in later work (Kaldor, 1966).

p.395). The static, dynamic and macro increasing returns to scale described above are captured by Verdoorn's law (Kaldor, 1966).

The argument however departs from that of Kaldor (1957) as demand for labour is treated as derived demand, responding to changes in the actual rate of growth. Following an increase in demand for labour, this is most likely to happen in the boom period, there are reductions in the unemployment rate as well as decreases in labour underemployment as more of the labour force is absorbed into productive activities. Secondly, participation rates by age and gender may increase as they vary cyclically with demand pressure. Finally, labour supply is elastic to demand due to migration, this is true for both international and regional migration.

The elasticity of labour to demand for developed and developing countries is expected to differ with the latter experiencing a higher elasticity of demand (Dray and Thirlwall, 2011). This is due to higher underemployment levels, larger gaps in participation rates by age and gender and lower productivity levels which characterise the labour market in developing countries.

2.1.4.1. The Empirical Literature on the Endogeneity of G_N

The endogeneity of the natural rate of growth is most commonly determined by estimating the natural rate of growth and testing if it increases during the boom periods. This is done by adding a dummy variable which represents the boom.

Several researchers have used different estimation techniques to determine the endogeneity of the natural rate of growth. Applying Ordinary Least Squares (OLS), Leon-Ledesma and Thirlwall (2002) used data on 15 OECD countries for the 1960 to 1995 period and found that the dummy variable was significantly positive for all countries used in the analysis. As a robustness test, the researchers go on to carry out Granger causality analysis between inputs and outputs for if the natural rate of growth is endogenous, then an exogenously determined production frontier as specified in orthodox growth theory, does not exist. The production frontier instead moves with each movement of the actual rate of growth (Leon-Ledesma and Thirlwall, 2002).

Two variables are used in the analysis, the log of GDP and the log of total factor inputs. Out of the 15 countries analysed, 13 showed bi-directional casualty between output and total factor productivity. The results therefore show that both inputs and outputs adapt endogenously to their long run relationship. This provides strong evidence for the endogeneity of the natural rate of growth.

Applying a similar technique, Dray and Thirlwall (2011) estimated the sensitivity of the natural rate of growth to the actual rate of growth for a selection of 10 Asian countries for the 1982 to

2005 period. Results show that the natural rate ranged from 2.8% for the Philippines and 10.4% for China. When testing for the endogeneity of the natural rate of growth, they find the dummy variable and constant are statistically significant for all countries expect for the Philippines.

Vogel (2009) uses a system of Seemingly Unrelated Regressions (SUR) estimations for 11 Latin-American countries for the 1986 to 2003 period. The average natural rate of growth estimated ranged from 1.8% for Venezuela and 6.1% for Chile. After adding the dummy variable, it was found to be significant at the 99% level for all countries. Demand was therefore found to be relevant for the respective countries.

Lanzafame (2014) used panel data for 22 OECD countries for the 1960 to 2010 period. He used fixed effects to determine the natural rate of growth for each country. The average natural rate of growth was found to be 3%. Results from the endogeneity test signalled that on average, growth increased by 3.3 percentage points when the actual rate of growth was above the natural rate of growth. Lanzafame (2009) also used panel data to determine if regional growth in Italy was endogenous. For the 1977 to 2003 period, results showed that growth was endogenous in only 8 out of 20 Italian regions.

Several studies have been carried out on the endogeneity of the natural rate of growth for various countries however no studies have been carried out for low income countries or the sub-Saharan African region. Closing the gap in the literature is imperative as it would shed light on the relevance of aggregate demand for the growth process in the region.

2.1.5. Extending the Harrod-Domar Model to an Open Economy

Thirlwall (2001) extended the Harrod (1939) model to an open economy by introducing a fourth growth rate, the balance of payments equilibrium growth rate, G_B,

$$G_B = \frac{x}{\pi} \qquad \text{(Equation 2.29)}$$

where, x is the growth of exports and π, the income elasticity of demand for imports. Assuming that deficits cannot be financed indefinitely, a constant real exchange rate and constant relative prices, G_B, is the growth rate consistent with equilibrium on the current account balance (Thirlwall, 2001).

The balance of payments equilibrium growth rate originates from the Harrod (1933) foreign trade multiplier which shows that under certain assumptions, income adjusts to restore equilibrium on the current account of the balance of payments. Taking the simplest case, income, Y, is derived from the production of consumption goods, C, and exports, X,

$Y = C + X$ (Equation 2.30)

All income is spent on consumption goods, C, and imports, M,

$Y = C + M$ (Equation 2.31)

There is therefore no savings or investment. The real terms of trade are assumed to be constant, so when trade is balanced, X=M. Exports are taken as given, based on the domestic cost of production and world prices and demand. A constant fraction of income, i, is devoted to imports[12] thus,

$M = iY$ (Equation 2.32)

When trade is balanced,

$X = iY$ (Equation 2.33)

Hence,

$Y = \frac{X}{i}$ (Equation 2.34)

Therefore,

$\frac{\Delta Y}{\Delta X} = \frac{1}{i}$ (Equation 2.35)

The multiplier, 1/i, returns the balance of payments to equilibrium through changes in income, Y brought on by a change in exports, X or imports. Equation 2.35, shows that the balance of payments matter for income determination and therefore economic growth. The balance of payments equilibrium growth rate given in Equation 2.29, is the dynamic Harrod (1933) foreign trade multiplier. It therefore follows that,

> *"A full understanding of growth performance and equilibrium in an open economy depends on the relation between g_w, g_n, and g_b" (Thirlwall, 2001, p.82).*

If the natural rate of growth is above the balance of payments constraint growth ($G_N > G_B$), there will be a deficit on the current account leading to capital inflows. This in turn will increase the warranted rate of growth. However, as a country cannot indefinitely run a current account deficit,

[12] In this example, we use the value of imports as defined by Harrod (1933). This can further be developed by using the import demand function where,

$M = \overline{M} + mY$

Where, $\overline{M}$, are autonomous imports. It therefore follows that,

$Y = \frac{(X - \overline{M})}{m}$ Hence, $\frac{\Delta Y}{\Delta (X - \overline{M})} = 1/m$

In this case the multiplier, 1/m, returns the balance of payments to equilibrium through changes in income, Y brought on by a change in exports, X or autonomous imports, $\overline{M}$.

long run growth is thus constrained by the balance of payments equilibrium growth rate. For most countries demand constraints operate long before supply constraints take effect (Thirlwall, 2013).

> *"Even if $g_w = g_n$ as long as g_b is below g_n, the economy cannot grow at its capacity rate" (Thirlwall, 2001, p.85).*

If however the balance of payments constrained growth exceeds the natural rate of growth ($G_N < G_B$), the economy will run a balance of payments surplus, leading to capital outflows and a reduction in the warranted rate of growth. In this case, the actual rate of growth can exceed the natural rate of growth without facing balance of payments problems. As the natural rate of growth is endogenous, it will increase following the increase in output.

Lanzafame (2014) empirically tested the relationship between the natural rate of growth and the balance of payments constrained growth rate. Using data on 22 OECD countries for the 1960 to 2010 period, he provided evidence that the natural rate of growth was equal to the balance of payments constrained growth rate. Applying Granger causality tests, he provided further evidence that there was unidirectional long run causality from the balance of payments constrained growth to the natural rate of growth therefore reinforcing the view that long run growth is demand determined and constrained by the balance of payments. As far as we are aware, this is the only study that tests the relationship between the two growth rates. No studies have been carried out for low income countries or the sub-Saharan African region.

Other post-Keynesian open economy growth models are the export-led cumulative causation model (Kaldor, 1970) and the balance of payments constrained growth model (Thirlwall, 1979). The strengths and limitations of both are discussed next.

2.1.6. The Export-Led Cumulative Causation Growth Model

The Kaldor (1970) model was developed to explain growth rate differences between regions within a country and between countries using the principle of cumulative causation coined by Myrdal (1957), to explain "endogenous factors resulting from the process of historical development" (Kaldor, 1970, p.487). Unlike the theory of comparative advantage which is sector indifferent, it recognises the industrial sector as key to economic growth and development.

The starting point of the model is two regions isolated from each other, A and B. Each has an agricultural sector, whose size of production depends on the soil, climate and the level of technology used. Each region also has an industrial sector, with the size of production dependent on derived demand for industrial products from the agricultural sector. Following the introduction of trade between the two regions, region A, whose industrial sector is more developed, will be capable of supplying the needs of the agricultural sector in region B on better terms. Thus the industrial sector in region B will tend to be eliminated as it loses its market to region A. As the size of production in the agricultural sector depends on the general fertility of the soil and technology employed, there will be no “compensating advantage” to region B in terms of agricultural output (Kaldor, 1970).

In addition, the adjustment mechanism to interregional trade and money flows differs for land based (agricultural) activities and processing (industrial) activities. In the former prices automatically adjust in response to variations in supply and demand balance, thus maintaining balance in trade flows between regions through income and substitution effects related to price changes[13].

For processing activities, which are characterised by imperfect competition and some ability to set prices, the adjustment mechanism takes place through the foreign trade multiplier. Exogenous changes in external demand for a regions products, “will set up multiplier effects in terms of local production and employment” (Kaldor, 1970, p.485), which under certain assumptions is sufficient to keep trade flows balanced.

The Hick’s (1950) super-multiplier shows the effect that changes in autonomous demand have on investment and consumption. Exports are identified as an autonomous component of demand as their demand originates from outside the region. The super-multiplier is therefore applied in a way that expresses the foreign trade multiplier in a dynamic setting.

> *“So expressed, the doctrine asserts that the rate of economic development of a region is fundamentally governed by the rate of growth of its exports. For the growth of exports, via the accelerator, will govern the rate of growth of industrial capacity, as well the rate of consumption,” (Kaldor, 1970, p.486).*

Exports in turn depend on the exogenously determined growth rate of world demand and the movement in relative efficiency wages, defined as the index of money wages divided by the index of productivity.

Central to the model is Verdoorn’s law which states the positive relationship between productivity growth and output growth. These increases in productivity are not likely to be fully compensated by changes in the money wage. Thus in regions where productivity growth rises faster than average, efficiency wages will tend to fall. A fast growing region therefore gains a “cumulative competitive advantage” over the slower growing region.

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[13] This applies to trade between two agricultural areas (Kaldor, 1970).

"It is through this mechanism that the process of cumulative causation works: and both comparative success and comparative failure have self-reinforcing effects in terms of industrial development" (Kaldor, 1970, p.487).

Dixon and Thirlwall (1975) formalised the Kaldor (1970) model and empirically tested it for Britain using data covering the 1951 to 1966 period. While the application of the model was "not inconsistent with the evidence," the model over predicted Britain's growth rate (Dixon and Thirlwall, 1975, p.231). The model was further criticised for being unrealistic due to the lack of a balance of payments constraint.

Thirlwall and Dixon (1979) modified the Kaldor (1970) model to include a balance of payments constraint. Under certain assumptions, the growth rate consistent with equilibrium on the balance of payments is determined by the growth of exports and the income elasticity of demand for imports, i.e. the dynamic foreign trade multiplier or the balance of payments constrained growth rate. The cumulative causation mechanism is thus "thwarted" as a country cannot grow faster than its equilibrium balance of payments growth rate (Blecker, 2009). Exports however still play a central role as they allow imports to increase without facing balance of payments difficulties.

2.1.7. The Balance of Payments Constrained Growth Model

Thirlwall (1979) developed a post-Keynesian long run growth model, which gives a central role to demand using Harrod's (1933) foreign trade multiplier. As in the Kaldor (1970) model, exports are considered as a vital component of autonomous demand. The original Thirlwall (1979) balance of payments constrained growth model starts with the balance of payments equilibrium condition,

$$P_d X = P_f M E \qquad \text{(Equation 2.36)}$$

where, P_d is the price of exports in the domestic currency, X is the volume of exports, P_f is the price of imports in foreign currency, M is the volume of imports and E is the exchange rate measured as the domestic price of foreign currency.

Taking the logarithms and differentiating with respect to time Equation 2.36 gives,

$$p_d + x = p_f + m + e \qquad \text{(Equation 2.37)}$$

where the small case letter, x is the growth rate of exports, m is the growth rate of imports, e is the growth rate of the exchange rate, p_d is the growth rate of domestic prices and p_f is the growth rate of import prices.

The import and export demand functions with constant elasticities are as follows:

$$M = a\left(\frac{P_f E}{P_d}\right)^{\psi} Y^{\pi} \quad \text{(Equation 2.38)}$$

$$X = b\left(\frac{P_d}{P_f E}\right)^{\eta} Z^{\varepsilon} \quad \text{(Equation 2.39)}$$

where, a and b are constants, Y is domestic income, Z is the level of world income, ψ is the price elasticity of demand for imports, η is the price elasticity of demand for exports, π is income elasticity of demand for imports and ε is the income elasticity of demand for exports. Taking the logarithms of Equations 2.38 and 2.39 and differentiating with respect to time,

$$m = \psi(p_f + e - p_d) + \pi y \quad \text{(Equation 2.40)}$$

$$x = \eta(p_d - e - p_f) + \varepsilon z \quad \text{(Equation 2.41)}$$

where, m is the growth rate of imports, p_f is the growth rate of foreign prices, e is the growth rate of the exchange rate, p_d is the growth rate of domestic prices, y is the growth rate of domestic income, x is the growth rate of exports, and z is the growth rate of world income.

Equation 2.40 and 2.41 are then substituted into Equation 2.37 giving,

$$p_d + (\eta(p_d - e - p_f) + \varepsilon z) = p_f + (\psi(p_f + e - p_d) + \pi y) + e \quad \text{(Equation 2.42)}$$

Solving for the growth of income gives the balance of payments constrained growth rate, y_B,

$$y_B = [(1 + \eta + \psi)(p_d - p_f - e) + \varepsilon z]/\pi \quad \text{(Equation 2.43)}$$

Under the assumption that the sum of the price elasticities ($\eta+\psi$) is equal to unity in absolute values, and/or if relative prices in international trade, i.e. the real exchange rates are constant, then Equation 2.43 reduces to,

$$* \, y_B = \varepsilon z/\pi \quad \text{(Equation 2.44)}$$

where the balance of payments constrained growth rate, $*y_B$, is equal to the income elasticity of demand for exports multiplied by the growth in world income, εz, divided by the income elasticity of demand for imports, π. Based on the same assumption of constant relative prices, Equation 2.44 can further be reduced to,

$$y_B = x/\pi \quad \text{(Equation 2.45)}$$

where the balance of payments constrained growth, y_B, is equal to the growth in exports, x, divided by the income elasticity of demand for imports, π. Perraton (2003) described Equation 2.44 as the strong version of Thirlwall's law as both the import and export demand functions need to be estimated while Equation 2.45, was recognised as the weak version of Thirlwall's law as only the import demand function is needed to derive the balance of payments constraint growth rate. Equation 2.45 is identical to the balance of payments equilibrium growth rate given in Equation 2.29.

2.1.7.1. Extensions to the Model

The original model described above was extended to include capital flows and the terms of trade (Thirlwall and Hussain, 1982). The extension is particularly relevant for developing countries, where capital flows, changes in the terms of trade and the real exchange rate have been very important. An outline of the model can be seen in Appendix F.

The extended model with capital flows and the terms of trade was first empirically tested by Thirlwall and Hussain (1982) for 20 developing countries covering the 1951 to 1969 period. Just three sub-Saharan African countries were included in the study: Kenya, Sudan and Zaire[14]. The weak version of Thirlwall's law as given in Equation 2.45, as well as an extended model which incorporates growth in real capital flows and the terms of trade effects was used. Their results showed that the countries in the sample had a "very mixed" experience, however on balance, changes in the terms of trade constrained growth by 0.6% per annum while capital inflows relaxed the balance of payments constraint and allowed countries to grow faster by about 0.05% per annum.

The researchers also divided the sample of countries into two subgroups, the first consisting of those countries where the balance of payments constrained growth model given in Equation 2.45 under predicted the actual growth rate, $y>y_B$, and those where it over predicted the growth rate $y<y_B$. As expected, in the first group where $y>y_B$, the rate of growth of real capital inflows was greater than the growth of exports therefore contributing to the positive difference. For the countries where $y<y_B$, the rate of growth of capital flows was below the rate of growth of exports for the majority of the countries in the group; however the dominant constraint to growth was the adverse effects of relative price movements.

Hussain (1999), tested the weak version of Thirlwall's law, extending the model to account for capital flows and the terms of trade as outlined by Thirlwall and Hussain (1982), for 29 African and 11 Asian economies covering the 1970 to 1990 period. His results for the group of African and Asian countries, when tested separately, provided evidence that both the original weak version and the extended model were good predictors of actual growth. However when the country groups

[14] Zaire is now known as the Democratic Republic of Congo.

were combined, the extended model was "superior" to the original model. For the entire sample of 40 countries, the original model gave valid predictions for 55% of cases while the extended model faired at 73%. Hussain (1999) therefore concludes that the extended model developed by Thirlwall and Hussain (1982), is the most appropriate model for sub-Saharan Africa. One of the limitations of the study is that OLS was used to estimate the import demand functions for each country without pre testing the stationarity of the data. The results obtained may therefore be spurious.

Due to the tendency of the Thirlwall and Hussain (1982) model to over predict the rate of growth, the model was extended by Elliott and Rhodd (1999, p.1146) to include interest rate payments for, "demand financed by capital flows generally carries with it debt accumulation and servicing". Drawing from the sample of countries employed in the Thirlwall and Hussain (1982) study and extending the model to include external debt financing, Elliott and Rhodd (1999) were able to reduce the degree of over prediction for 9 out of 13 countries, concluding that economic growth is additionally constrained by debt service payments which drain on the limited financial resources needed for economic growth.

The extended balance of payments constrained growth rate developed by Thirlwall and Hussain (1982) and later modified by Elliott and Rhodd (1999) was further criticised by Moreno-Brid (2003) as the models did not set a limit to the amount of capital flows into a country and therefore assumed that a country can forever increase its level of indebtedness relative to GDP. In practice, a developing countries creditworthiness and therefore access to global financial markets is influenced by its debt accumulation as perceived by the creditors as the current account to GDP ratio and the foreign debt to GDP ratio. As these ratios increase and reach critical levels, developing countries may experience difficulties in attracting foreign capital. This was seen in the 1980's debt crisis which affected many developing countries including Latin America and sub-Saharan Africa (Devlin and Ffrench-Davis, 1995).

Sustainable debt accumulation is incorporated into the model by imposing a long run constraint taken as a constant ratio of the current account deficit to income (Moreno-Brid, 2003). This version of the model which accounts for sustainable debt accumulation, interest rate payments abroad and the terms of trade has not been tested for the sub-Saharan African region. It has however been tested by Moreno-Brid (2003) for Mexico[15], with the results providing support for the balance of payments constrained growth model as well as the importance of interest payments abroad as an additional binding constraint to Mexico's growth rate.

[15] The model empirically tested by Moreno-Brid (2003) assumed that the terms of trade are constant.

Other extensions of the model include Nell (2003) and Lanzafame (2014). Nell (2003) generalised the balance of payments constrained growth model to include many countries. He was therefore able to analyse South Africa's balance of payments constraint with respect to the OECD and the rest of the Southern African Development Community (RSADC). The results showed that South Africa was only balance of payments constrained with respect to the OECD and faster growth rates may be the result of an improvement in the structural demand feature of its exports to the OECD.

Lanzafame (2014) synthesised the two growth literatures on the Harrod (1939) natural rate of growth and the balance of payments constrained growth model building on the work of Thirlwall (2001). This was discussed in section 2.1.5.

One of the implications of Thirlwall's (1979) model is that the structure of production and exports determines the income elasticity of demand for exports which therefore determines the rate of growth of one country relative to another. What a country exports has to do with how its economic activity is structured. There is a long understanding in the economic growth and development literature that there is a causal relationship between growth in the manufacturing sector and growth in GDP (Kaldor, 1966).

2.1.8. Latin American Structuralism: The Prebisch-Singer Hypothesis

The Prebisch-Singer hypothesis developed by Prebisch (1950) and Singer (1950), states that primary commodity prices relative to manufactured products exhibit a downward circular trend, i.e. over time the terms of trade move against primary products in favour of manufactured products. The theory proposed by Prebisch (1950) is further explored as it directly relates to the problems faced by Latin America. These same problems are faced by many developing countries in the world.

The Latin American school of structuralism began with Prebisch (1950) who recognised that although the "outdated schema" for the international division of labour was theoretically sound, it was based on an assumption that was overwhelmingly proven false by reality. This crucial assumption is that the benefits of technological progress are equally distributed to the whole "community" either through the increase in incomes or lowering of prices. The problem arises with the interpretation of "community" as it cannot be generalised to include the periphery of the world economy as,

> *"The enormous benefits that derive from increased productivity have not reached the periphery in a measure comparable to that obtained by the people of the great industrial countries…. Thus there exists an obvious disequilibrium, a fact which, whatever its explanation or justification, destroys the basic premise underlying the schema of international division of labour" (Prebisch, 1950, p.1).*

Instead of witnessing a decrease in the price for industrial products as opposed to primary products due to greater technological progress in industry, the price relation has moved against primary production from the 1870s to 1940s. Prebisch (1950) illustrates this as in the 1940s, 68.7% more primary products were needed to purchase the same amount of manufactured products than that required in the 1860s. Although the data used in the study carried out by Prebisch (1950) has been criticised for being incomparable and inconsistent, other studies, particularly studies that include the 1980s period, find that the terms of trade for commodity prices have deteriorated in comparison to manufactured products (Sapsford, 1985; Sarkar, 1986; Helg, 1991; Leon and Soto, 1997; Erten, 2011; Arezki et al, 2013).

Another noticeable characteristic is that average per capita income increased more in the industrial centres compared to the primary goods producing periphery. This was described by Prebisch (1950, p.14),

> *"…the phenomenon whereby the great industrial centres not only keep for themselves the benefit of the use of new techniques in their own economy, but are in a favourable position to obtain a share of that deriving from the technical progress of the periphery."*

According to Prebisch (1950), this phenomenon could be explained by the trade cycle, which manifests itself differently at the centre and the periphery. The trade cycle is a cyclical process in the industrial centres brought about by the disequilibrium between aggregate supply and demand. In the upswing, demand is greater than supply causing profits to rise. Part of these profits are transferred from entrepreneurs in the centre to primary producers in the periphery as prices of primary products rise faster than those of finished products. This is due to the fixed nature of primary products, i.e. producers tend to have little control over the organisation and production of their output while producers of manufacturing goods can more readily alter their supply to meet demand. A proportion of the profits will also be absorbed by an increase in wages at the centre due to competition amongst entrepreneurs as well as pressure from trade unions.

During the downswing profits fall however, they do not fall in the same fashion in which they rose. For starters, prices for primary products fall much more in the downswing compared to finished products, for reasons explained above therefore progressively widening the price gap between the two in the course of the cycles. Secondly, due to wage rigidities in the centre, the profits that were absorbed by wages during the upswing lose their fluidity. Pressure therefore moves to the periphery where lack of organisation amongst the labour force in primary production leads to a contraction of income. As noted by Prebisch (1950, p.13)

> *"The less that income can contract at the centre, the more it must do so at the periphery."*

Based on this proposition, Prebisch (1950) concluded that any programme of economic development that attempts to raise real income should include anti-cyclical policies.

As prices do not fully reflect productivity, countries in the periphery can only fully benefit from technical progress through industrialisation. The countries in the periphery are not in the position to influence exports as these are mainly determined by income in the industrial centres, for instance the United States of America (US) or Europe and their respective import coefficients. In addition, the countries in the centre, particularly the US, have been decreasing their import coefficient as a way of overcoming rising unemployment.

Tariffs and other trade restrictions, have consequences for the periphery who rely on their markets for their exports. Resources made available through exports are not sufficient to finance industrialisation. A reduction in the import coefficient in the periphery countries was therefore seen as necessary by reducing the import of non-essential goods, to be replaced with domestically produced goods, so that the import of capital goods needed in industry could be increased. This led to the adoption of import substitution policies which were mainly applied in the 1950s to 1980s. These policies aimed at encouraging industrialisation and self-sufficiency by protecting domestic production from foreign competition through the use of quotas, tariffs, subsidies and special licenses applied to both imports and exports.

According to Singer (2003), the Prebisch-Singer thesis does not indicate if the shift to industrialisation should be achieved through promoting the export of manufactured products or through the implementation of import substitution policies for previously imported finished products. The reason the latter was preferred in the 1950s and 1960s was twofold; domestic production capacity needed to be built in developing countries in order for them to export manufactured products and producing for an existing and familiar domestic market would be easier than trying to compete in global foreign markets.

Singh (1994) showed that during the 1960 to 1980s period, the medium growth rate in 9 major Latin American countries and 9 major East Asian “miracle” countries was not statistically distinguishable. This was a period that is often referred to as the “Golden Age” for developing countries as they experienced rapid growth no doubt benefiting from the international post war environment where the industrialised countries experienced capacity shortages and high demand for raw materials (Cardoso and Helwege, 1992).

Following the 1980s recession, there was divergence in the growth rate of the Latin American and East Asian countries however, the East Asian countries were able to recover and achieve high sustainable growth rates. Import substitution policies were adopted by many newly independent

African countries at the time. The results, like in the Latin American case were disappointing leading the way to a new set of policies, namely structural adjustment programs discussed in section 2.2.4. The latter are embedded in neoclassical economics.

Controversy persists in accounting for the reasons why the East Asian model was a "success" and the Latin American model a "failure". Whether or not it resulted from poor micro and macroeconomic policies pursued by Latin America or the close international integration that was characterised by the East Asian export-oriented model, there is consensus on the central and active role that the government played to deliberately pursue industrialisation.

2.1.9. The Big Push and Balanced Growth Models

The idea of the big push, which is large-scale and planned industrialisation in depressed regions, was first advocated by Rosenstein-Rodan (1943) as a way of raising incomes in the depressed regions of Eastern and South-Eastern Europe so that the income gap between these countries would be narrowed, i.e. convergence. In a nutshell, Rosenstein-Rodan (1943, p.202) summarised the model,

> *"If the principles of international division of labour are to be applied, labour must either be transported towards capital (immigration) or capital must be transported towards labour (industrialisation)."*

On a large scale, industrialisation was considered the more feasible option due to the disruption and turmoil that would arise from migration however he acknowledged that even a bold and optimistic program of industrialisation would not absorb the entire surplus population that is unemployed and thus recommended that migration supplement industrialisation.

The logic applied by Rosenstein-Rodan (1943) can easily be extended to all depressed world regions. According to this model, there are two ways in which a country can industrialise. The first would be to follow the Russian model which aims for self-sufficiency without international investment. This would result in a heavy and "unnecessary sacrifice" as consumption, already very low in depressed regions, is further reduced in order to finance industrialisation. The second option, deemed the better option as it does not require any sacrifice to consumption and results in larger world income, is based on international investment or capital lending. The model was further developed by Nurkse (1953), Fleming (1955) and Murphy et al (1989). Closely related to this literature is that of unbalanced growth which emphasises the benefits possible through backward and forward linkages by targeting large scale investment in particular industries (Hirschman, 1984).

The main reason for large-scale and planned industrialisation is the advantages that are to be achieved through the complementarity of different industries. For instance, if one million unemployed workers were put into a series of industries which adopted increasing returns technologies to produce the majority of the goods which the workers spend their wages on, the risk faced by entrepreneurs of not being able to sell their products would be reduced as this planned complementary system creates its own additional market through the creation of income. It thus ignites a chain of virtuous circles as the simultaneous industrialisation of many sectors in the economy becomes self-sustaining as each sector creates demand for the other. The country will also be able to benefit from other externalities characterised by a firm within a growing industry such as knowledge spillovers, close proximity of specialised suppliers and labour pooling (Lyn and Rodriguez-Clare, 2011). The model is also referred to as balanced growth, i.e. simultaneous growth in different sectors.

As elaborated by Murphy et al (1989) domestic demand plays a vital role for industrialisation in the absence of free and costless trade. Early work by Chenery et al (1986) provides evidence of the significance of the domestic market for industrialisation as they found that in countries with a population of over 20 million, about 72% to 74% of the increase in domestic industrial output was the result of an expansion of domestic demand. Between 1955 and 1973, growth in domestic demand contributed as much as 53% to growth in industrial output in South Korea, a small open economy.

> *"If the industrialisation of international depressed areas were to rely entirely on the normal incentives of private entrepreneurs, the process would not only be very much slower, the rate of investment smaller and (consequently) the national income lower, but the whole economic structure of the region would be different" (Rosenstein-Rodan, 1943, p.207).*

This quote highlights the central role of the state in industrialisation. As the driving force for private investment is the expectation of future profits based on past profits, the state can provide investment in areas which are profitable in terms of social marginal product and not private marginal net product. Through acting as a supervisor and guarantor, the state plays an important part in minimising the risks associated with large scale international investment. In addition, the state may invest in training the labour force which is vital for industrialisation; this is typically seen as a bad investment for entrepreneurs as they are prone to lose capital if the trained worker takes up a contract.

2.2. Supply Side Models

Smith (1776), Malthus (1798) and Ricardo (1821) greatly influenced the classical and neoclassical school of thought. Smith (1776), was an advocate of the "invisible hand" which corrected market imperfections and was therefore against government interference in the market.

Malthus (1798) is best known for his contribution to population growth. He begins with two postulata, first that food is necessary for the existence of man and second, that passion between male and female is necessary and will continue to be so as it has been for thousands of years. Given these two postulata, he states that,

> *"…the power of population is indefinitely greater than the power in the earth to produce subsistence for man. Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio" (Malthus, 1798, p.4).*

Ricardo (1821) like many of his predecessors was concerned with population growth and the ability of the land to provide the necessities of life. Building on the ideas by Smith (1776) and Malthus (1798), he introduced the concept of diminishing returns to agriculture. These ideas of capital accumulation, market efficiency, population growth and diminishing returns make up the bedrock of ideas that underpin classical economics as well as inform the neoclassical, new endogenous and new institutionalist growth models of economic growth which will be discussed in detail below.

Ricardo (1821) also developed the theory of comparative advantage which has inspired neoliberal policies aimed at reducing trade barriers and minimising the role of the state in economic activities. An outline of the theory is given in section 2.2.4.

The Lewis (1954) dual sector model is included in this section as it is developed specifically for developing countries. It is strongly inspired by the ideas of classical economics where the assumption of an unlimited supply of labour holds.

2.2.1. The Neoclassical Model with Exogenous Technological Change

The Solow (1956) model outlined in section 2.1.2, has become the basis for neoclassical growth models. In the steady state, growth in investment per worker is equal to the exogenously determined labour force growth, n. Due to constant returns to scale, growth in output is therefore also equal to n. The condition that the change in the capital labour ratio is zero ensures that there is no growth in per capita output. This outcome is at odds with stylised facts that showed countries with high levels of capital deepening were able to experience sustained growth in per capita income.

The model was therefore extended to include exogenous technological change. The Cobb-Douglas production function with constant returns to scale and diminishing returns to factors of production is assumed,

$$Y = F(K, L) = K^{\alpha}L^{1-\alpha} \quad \text{(Equation 2.50)}$$

where α, is the elasticity of output with respect to capital and 1- α is the elasticity of output with respect to labour. α is a number between 0 and 1 so that, $\alpha + (1 - \alpha) = 1$.

There are different ways of introducing the technology variable, A. "Solow neutral" technological change can be introduced by multiplying the production function by an increasing scale factor. This is not explored further as it simply has the effect of "blowing up" the sF(r,1) curve shown in Figure 2.1, without changing the isoquant map[16]. Technology may also be introduced as "capital augmenting," which is also not explored further as most growth models, of both endogenous and exogenous types, assume technical progress to be "purely labour augmenting" (Acemoglu, 2000, p.1).

We therefore focus on "Harrod-neutral" technological change, which is "labour augmenting" while leaving the capital output ratio unchanged,

$$Y = F(K, AL) = K^{\alpha}(AL)^{1-\alpha} \quad \text{(Equation 2.51)}$$

Technology is assumed to be exogenous like,

> *"…manna from heaven in that it descends upon the economy automatically and regardless of whatever else is going on in the economy" (Jones, 2002, p.36).*

Technology, A, is assumed to grow at a constant rate, g,

$$A = A_0 e^{gt} \quad \text{(Equation 2.52)}$$

Therefore,

$$\frac{\dot{A}}{A} = g \quad \text{(Equation 2.53)}$$

We introduce the capital technology ratio, $\tilde{r}$,

$$\tilde{r} = \frac{K}{AL} \quad \text{(Equation 2.54)}$$

Taking logs and differentiating,

[16] Output attached to each isoquant is multiplied by the technology variable A. The shape of the isoquant remains unchanged however the corresponding output is larger by A (Solow, 1956).

$$\frac{\dot{\tilde{r}}}{\tilde{r}} = \frac{\dot{K}}{K} - \frac{\dot{A}}{A} - \frac{\dot{L}}{L} \quad \text{(Equation 2.55)}$$

We recall the capital accumulation equation from section 2.1.2,

$$\dot{K} = sY \quad \text{(Equation 2.10)}$$

Substituting in Equation 2.55, $\frac{\dot{L}}{L}$, for n, $\frac{\dot{A}}{A}$, for g, and $\dot{K}$,

$$\frac{\dot{\tilde{r}}}{\tilde{r}} = \frac{sY}{K} - g - n \quad \text{(Equation 2.56)}$$

$$\dot{\tilde{r}} = \frac{K}{AL}\frac{sY}{K} - (g+n)\tilde{r} = s\tilde{y} - (g+n)\tilde{r} \quad \text{(Equation 2.57)}$$

where $\tilde{y} = \frac{Y}{AL}$. In the steady state, there is no change in the capital technology ratio, $\dot{\tilde{r}} = \frac{K}{AL} = 0$. In graphical terms, this would be the point where the $s\tilde{y}$, and $(g+n)\tilde{r}$, curves intersect. The capital technology ratio $\tilde{r}*$, will develop and be maintained. The economy will therefore grow at a balanced growth path determined by exogenous technological change, g and growth in the labour force, n. Growth in per capita income will be equal to growth in technology.

2.2.1.1. The Empirical Literature on the Neoclassical Model

The Solow (1956) model with exogenous technological change has been empirically tested. One of the predictions in the model is the inverse relationship between a country's per capita growth rate and its starting level of income per capita. Based on the assumption that countries have similar tastes and preferences and equal levels of technology which grows at the constant rate, g, due to diminishing returns to capital, rich countries will have higher capital labour ratios than poor countries resulting in a higher marginal product of capital in the latter. Poor countries will therefore grow faster than rich countries as they accumulate capital, thus narrowing the income per capita gap between rich and poor countries, a process referred to "unconditional" convergence.

The first tests on the "unconditional" convergence hypothesis were applied by Abramovitz (1986) using data for 16 countries from the Maddison (1982) dataset for 16 industrialised countries covering the 1870 to 1979 period. The results found evidence of convergence between countries, provided that countries had a social capability sufficient to absorb more advanced technologies. Baumol (1986) used the same dataset and found that convergence was shared between industrialised countries. Their finding however were criticised by De Long (1988) who noted that the data provided by Maddison (1982) was for 16 successful capitalist nations therefore making the sample "ex post". De Long (1988) therefore used an "ex ante" sample of countries that in 1870 looked like they were likely to converge. His results indicated that the long run data showed no convergence between the relatively rich countries in 1870. One therefore has to acknowledge the possibility that the relative income gap between the rich and poor may actually widen.

Subsequently there have been a number of studies testing the "unconditional" convergence hypothesis. Empirical results for OECD countries find evidence of "unconditional" convergence however large cross country studies find no evidence of convergence (Mankiw et al, 1992; Jones, 2002).

The failure for countries to converge was placed on the unrealistic assumptions that the investment ratio, population growth and technology are the same across countries. Empirical studies controlling for all factors that influence the above found evidence in support of "conditional convergence" (Mankiw et al, 1992). This was extended to control for human capital (Mankiw et al, 1992; Barro, 1991; Jones, 2002), as well as institutional and market factors (Barro, 1991; Barro and Lee, 1993).

Cross country per capita income can therefore be explained by variations in the rate of savings and population growth. Each country reaches a unique steady state, where investment in capital/technology per worker is equal to the growth in the labour force, n, and the growth in technology. Using annual data for 98 countries covering the 1960 to 1985 period, Mankiw et al (1992) provide empirical evidence that the rate of savings and population growth affect income as predicted by the model, accounting for 59% of the variation in income per capita. However, the respective magnitudes are inflated.

Mankiw et al (1992) therefore augment the Solow (1956) model by including human capital accumulation alongside physical capital accumulation. The augmented model accounted for 78% of the variation in per capita income. In addition, the effects of savings and population growth are reduced. The authors therefore conclude that, "the augmented Solow model provides an almost complete explanation of why some countries are rich and others poor" (Mankiw et al, 1992, p.408). The model however is acknowledged as being an incomplete theory of growth as savings, population growth and "worldwide" technological change are exogenously determined.

Jones (2002) also provides empirical evidence in favour of the augmented Solow model with human and physical capital accumulation. The main drawback of the model is identified as its inability to explain differences in technology across countries, resulting in the model over predicting the wealth of some nations. This latter reason, as well as the failure for countries to converge as originally predicted, led to the rise of new endogenous growth models which treat technological change as endogenous.

2.2.2. New Endogenous Growth Models

New endogenous growth models are distinguishable from neoclassical models as they emphasise that, "economic growth is an endogenous outcome of an economic system, not the result of forces that impinge from outside" (Romer, 1994, p.3). Their focus is on understanding the forces underlying technological progress, by relaxing two key assumptions in the neoclassical model. Firstly the assumption that technological change is exogenous and secondly, that its "opportunities" are equally available to all countries (Romer, 1994).

There is a diverse body of theoretical and empirical work on endogenous growth models. Early models include the AK theory, which does not make a distinction between capital accumulation and technological progress. It starts with the neoclassical production function however the assumption of diminishing returns to factors is abandoned. The marginal return to capital in the aggregate production function could be constant or increasing as diminishing returns to the marginal rate of capital are offset by technological progress which is created by intellectual capital driven by capital accumulation.

Unlike the Solow (1956) model, the economy is always on a balanced growth path. In addition, savings matter for long run growth. Saving a large fraction of income, part of which will finance technological progress, is seen as the driver of sustained economic growth.

The innovation based theories followed the AK models. These recognise that intellectual capital, which grows through innovation, is different from physical and human capital which are accumulated through savings and schooling (Aghion and Howitt, 2009). Two influential branches emerged; the product variety model (Romer, 1990) and the Schumpeterian models (Aghion and Howitt, 1992)[17]. The most widely referred to model was developed by Romer (1990). We therefore focus our discussion on the former.

The argument in the Romer (1990) model rests on three premises. Firstly, as in the Solow (1956) model, technological change, defined as the, "improvement in the instructions for mixing raw materials together," is the driver of long run economic growth (Romer, 1990). Secondly, technological change arises from the intentional actions of people in response to market incentives, therefore making it endogenous. Thirdly creating "instructions" or designs differ from other economic goods in the sense that it entails high initial costs in producing the first unit, however subsequent units can be replicated at no additional cost. They are described as non-rival goods. According to Romer (1990), once the three premises are "granted" the assumption of perfect competition that make firms price takers has to be abandoned. The model could also be referred

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[17] For a more detailed discussion on Schumpeterian models please refer to Aghion and Howitt (2009).

to as neo-Schumpeterian due to Schumpeter's (1942) emphasis on the important motivating force that temporary monopoly power has on the innovation process[18].

Final output is a function of primary inputs, i.e. capital measured in units of consumption goods, K, labour taken as counts of people, L, human capital, H, measured as the cumulative effect of things such as formal education or on the job training and an index of the level of technology measured as the number of designs, A.

$$Y = F(K, L, H, A) \quad \text{(Equation 2.58)}$$

The model exhibits increasing returns to scale. There are constant returns to capital, labour and human capital however, there are increasing returns to A, instructions or designs as it is a non-rival partially excludable good.

Three different sectors are identified; the research sector, the intermediate sector and the final output sector. The research sector uses human capital, H_A and the existing stock of knowledge, A, to produce new knowledge, $\dot{A}$,

$$\dot{A}(t) = \delta H_A A \quad \text{(Equation 2.59)}$$

Therefore the growth in new ideas is equal to,

$$\frac{\dot{A}}{A} = \delta H_A \quad \text{(Equation 2.60)}$$

where δ, is the productivity parameter. It therefore follows that the greater the number of people employed in the research sector, the greater the number of new designs produced. In addition, the higher the existing level of designs or knowledge, the higher the productivity of each worker employed in the sector. The model separates the rival component of knowledge as captured by, H_A, and the non-rival technological component, A, which under the functional form assumption that the output of designs is linear in A, allows the latter to grow without bounds[19].

The intermediate goods sector is characterised by monopolistic competition. Monopoly power is gained from the purchases of designs from the research sector that are used to produce capital goods sold to the final output sector. The production function for capital goods, x is,

$$x(i) = \eta Y \quad \text{(Equation 2.61)}$$

[18] See Romer (1994) for a full explanation on the reasons behind the rise of new endogenous growth models.
[19] The functional form assumption is made that the production function is linear in A and H_A, when each is held constant (Romer, 1990).

There is one firm for the production of each capital good i, which uses the design i, purchased from the research sector. $\dot{A}$, is therefore the number of new designs. ηY, is the portion of final product used as input. Prices for durable goods include a simple mark-up added to marginal costs, determined by the elasticity of demand.

The final goods sector employs labour, L, human capital, H_Y, and durable goods, x. The production function is,

$$Y(H_{Y,}L, x) = H_Y^{\alpha} L^{\beta} \int_0^{\infty} x(i)^{1-\alpha-\beta} di \qquad \text{(Equation 2.62)}$$

where capital is disaggregated into an infinite number of machines, x whose index i, is treated as a continuous variable. Under the assumption of symmetry in the model, i.e. all durable goods available are supplied,

$$Y(H_{Y,}L, x) = H_Y^{\alpha} L^{\beta} A \bar{x}^{1-\alpha-\beta} \qquad \text{(Equation 2.63)}$$

It is clear from the aggregate production function that equilibrium growth in output is equal to the growth in new designs, A. Knowledge enters the production process in two ways. Firstly, a new design allows for the production of a durable good that can be used to produce final output. In this sense, the non-rival partially excludable good, A, which exhibits increasing returns enters the aggregate production function indirectly through its effects on the availability of new capital goods, x. In addition, the new design will increase the total stock of knowledge which is available to all, resulting in positive knowledge spillover effects. The productivity of human capital in the research sector is therefore enhanced (Romer, 1990).

The economy will be on an equilibrium balanced growth path if the number of designs, A, capital, K, and income, Y, grow at a constant exponential rate (Romer, 1990). This requires that r, $\bar{x}$, and the ratio K/A is constant. As $\bar{x} = \frac{K}{\eta A}$, if K/A is constant then $\bar{x}$, is constant. A, will be constant if the amount of human capital employed in its production remains constant.

The amount of human capital employed in the research sector is endogenously determined. When on an equilibrium growth path, holders of human capital decide to work in the research or manufacturing sector based on the level of total knowledge, the price of designs and wages in the manufacturing sector.

$$H = H_A + H_Y \qquad \text{(Equation 2.64)}$$

where $H_A > 0$, and $H_Y < H$. As the research sector is characterised by perfect competition, the price of designs, P_A, will be bid up to the present value of the net revenue that the monopolist can receive from the design,

$$P_A = \pi \frac{1}{r} \qquad \text{(Equation 2.65)}$$

where π, is profit and r, the interest rate. As human capital is the only factor of production that is rewarded, wages in the sector w_A, is given by,

$$w_A = P_A \delta A \qquad \text{(Equation 2.66)}$$

The final good sector operates under perfect competition hence each factor of production, including human capital, is paid its marginal product. Due to free movement of human capital between sectors, wages are equalised. It therefore follows that human capital employed in the research sector will remain constant if the price for new designs is constant. This in turn depends on the interest rate[20]. The unambiguous and robust result arises that growth is related to the interest rate due to its effect on the amount of human capital employed in the research sector,

> *"If the interest rate is larger, the present discounted value of the stream of net revenue will be lower. Less human capital will be allocated to research and the rate of growth will be lower," (Romer, 1990, p.93).*

Alternatively a lower interest rate will result in higher growth. Balanced growth therefore exists if prices and wages are such that human capital employed in the final goods sector, H_Y, and human capital in the research sector, H_A, remain constant as Y, C, K, and A grow (Romer, 1990). Graphically, the equilibrium growth rate is the point of intersection between the Ramsey line and the Romer line[21].

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[20] From Equation 2.65, it is clear that the monopolist profit in the intermediate sector, is just enough to cover the cost of interest on the initial investment in a design (Romer, 1990).

[21] The equilibrium growth rate is determined by the intersection between the Ramsey curve which shows the positive link between interest rates and the Romer line which shows the negative link between growth and the interest rate. We start by specifying the rate of growth of consumption and the rate of intertemporal substitution,

$$\int_0^\infty U(C)e^{-pt}dt, \qquad with\ U(C) = \frac{C^{1-\sigma}-1}{1-\sigma}$$

Facing a fixed interest rate, r, the intertemporal optimisation condition for a consumer is,

$$\frac{\dot{C}}{C} = \frac{\dot{r} - p}{\sigma}$$

Where p is consumer impatience, taken as a constant. Next we can define the Romer line, which states that wages in the research sector is equal to, $P_A\delta A$, while wages in the final output sector are equal to the marginal product of labour.

$$w_H = P_A\delta A = \alpha H_Y^{\alpha-1} L^\beta A \bar{x}^{1-\alpha-\beta}$$

Wages in the research sector and final goods output sector are equalised due to free movement of human capital between sectors. Substituting the value for P_A, and solving,

$$H_Y = \frac{1}{\delta}\frac{\alpha}{(1-\alpha-\beta)(\alpha+\beta)}r$$

Equilibrium growth is therefore given by,

$$\frac{\dot{Y}}{Y} = \delta H_A = H_Y = \frac{1}{\delta}\frac{\alpha}{(1-\alpha-\beta)(\alpha+\beta)}r$$

$$\frac{\dot{Y}}{Y} = \frac{\dot{C}}{C} = \frac{\dot{K}}{K} = \frac{\dot{A}}{A} = \delta H_A = H_Y = \frac{1}{\delta} \frac{\alpha}{(1-\alpha-\beta)(\alpha+\beta)} r \qquad \text{(Equation 2.67)}$$

Under the assumption that A grows at an exogenous exponential rate, the model is reduced to the Solow (1956) model with labour enhancing exogenous technological change. Likewise if the level of A is assumed to be fixed, growth in the steady state is nil. The Romer model is therefore,

> *"…essentially the one-sector neoclassical model with technological change, augmented to give an endogenous explanation of the source of the technological change" (Romer, 1990, p.S99).*

We therefore do not assess the model further. In the next sub-section we discuss the Lewis (1954) model which is in essence the neoclassical model modified to take account of the growth process in developing countries.

2.2.3. The Lewis Dual Sector Model

> *"…hardly any progress has been made for nearly a century with the kind of economics which would throw light upon the problems of countries with surplus populations" (Lewis, 1954, p.400).*

Lewis (1954) wrote at a time when economic models based on the assumption of a limited supply of labour dominated. He argued that in order to understand economic development in a country with an unlimited supply of labour, as had been the case in some developing countries (he makes specific reference to Asia), the researcher had to go back to the classical writers whose models were based on the assumption of an unlimited supply of labour experienced in the now developed countries in their early stage of development.

He started with a closed economy with two sectors, subsistence and capitalist. Agriculture is the main activity in the subsistence sector employing most of the population. The sector is characterised by lower output per head than the latter as it does not make use of reproducible capital. Wages are determined by the average product of the worker which is usually at the minimum subsistence level. This sets a floor for wages in the capitalist sector as workers are paid the subsistence wage as well as (in most cases) a margin to compensate the worker for leaving his/her family in the subsistence sector.

Surplus labour in the subsistence sector due to disguised unemployment allows the capitalist sector to hire labour at the subsistence wage without causing wages to rise. The supply of labour is further increased through, (i) the transfer of women in the household to the workforce, (ii) the increase in unemployment due to increased efficiency, for instance the use of machinery, (iii) the increase in population due to economic development as births exceed deaths due to improved communication and connectivity between regions preventing deaths from famine. The population additionally takes advantage of modern medicine and health care facilities. This model only applies to unskilled labour as Lewis (1954) recognises the "quasi-bottleneck" that may arise from a shortage of skilled labour.

Capital and labour are employed in the capitalist sector creating a surplus for the capitalist. The key question of development is determined by how this surplus is used. If reinvested, it creates new capital thus causing the capitalist sector to expand as more people are employed. This results in an even larger surplus and the process continues until surplus labour ceases to exist. Once this point is reached, wages begin to rise.

Lewis (1954) extended the model to an open economy. He theoretically showed that if a country is surrounded by other countries, once surplus labour disappeared and wages began to rise, mass immigration and the export of capital would check the rise. By favouring an increase in the profit share as surplus increases and by suppressing wages so that they remain close to the subsistence level, the Lewis (1954) model implies increasing inequality with growth. This is consistent with the research done by Kuznets (1955) which provided evidence that growth caused inequality to rise in the early stages of development and decrease in later stages, thereby following an inverted-U shape. While this relationship is empirically verified by some (Ahluwalia, 1976; Ram, 1995; Bulir, 2001; Huang, 2004) it is rejected by others (Deininger and Squire, 1998; Frazer, 2006).

Alternative approaches to inequality and growth have since been proposed, including the political economy approach (Alesina and Perotti, 1996), the credit market imperfections model (Galor and Zeira, 1993) and the unifying approach (Galor and Moav, 2004).

The political economy approach to inequality is concerned with the destabilising effect that inequality has on society. Alesina and Perotti (1996, p.1) provided evidence using 70 countries for the period 1960 to 1985 that, "income inequality, fuelling social discontent, increases socio-political instability". This casts doubt on the feasibility of the Lewis (1954) model, for an increase in inequality may fuel social unrest in a region that is already politically vulnerable.

In addition, it has been empirically proven that the responsiveness of poverty to economic growth is largely affected by inequality (Ravallion, 1997; Bourguignon, 2003; Kalwij and Verschoor, 2007). An increase in inequality significantly reduces the elasticity of poverty to growth.

2.2.4. Specialisation and Comparative Advantage

Specialisation in accordance with existing comparative advantage had been one of the main policy recommendations from the major international institutions such as the World Bank and IMF. It is mainly influenced by Ricardo's (1815) theory of comparative advantage where the "enjoyments of life” would be increased through the improved distribution of labour. Each country should therefore produce commodities for which it has a “natural or artificial” advantage. These commodities would then be exchanged for the commodities of other countries. The increase in commodities would lead to a fall in their exchangeable value as the same revenue becomes efficient in procuring a larger amount of necessities. The model thus predicts a high degree of specialisation between countries.

The main critics of the models of international trade based on comparative advantage leading to specialisation are the school of Latin American Structuralism and the post-Keynesian school described in section 2.1. They argue that in line with their existing comparative advantage, developing countries are left specialising in the production of primary land based goods which exhibit diminishing returns and unfavourable terms of trade over time. This limitation arises as the model does not take sectoral differences into consideration, in particular the role of industry which is characterised by increasing returns to scale and high productivity growth.

The Institutionalist Political Economy (IPE) recognise the state as a powerful medium for institutional change. The main critique against trade liberalisation based on existing comparative advantage, is that it hinders developing countries from pursuing protectionist policies that are vital for developing new capabilities and industries i.e. diversification. Such policies in essence are aimed at “defying” not “conforming” to comparative advantage hence favouring diversification over specialisation.

It is also argued that specialisation leaves developing countries more vulnerable to external fluctuations and shocks. These conflicting views, between specialisation and diversification spurred the work of Imbs and Waczigarg (2003) who provided empirical evidence of a non-linear “U-curved” relationship between diversification of production and GDP per capita.

2.2.4.1. The Empirical Literature on Liberalisation

Models of international trade based on existing comparative advantage hold that trade is beneficial for all, although the gains may be unevenly distributed. The empirical literature however remains inconclusive. We focus on the literature from the late 1970s onwards for this is when the wave of liberalisation policies swept across the developing world. The two international financial institutions, the World Bank and IMF played a pivotal role in promoting these policies through loan conditionality and structural adjustment programs. Often referred to as the “Washington Consensus” policies prescribed include, “restrictive macroeconomic policy, liberalisation of international trade and investment, privatisation and deregulation” (Chang, 2002, p.1).

> *"When a country borrows from the IMF, its government agrees to adjust its economic policies to overcome the problems that led it to seek financial aid from the international community" (International Monetary Fund, 2016).*

In assessing the impact of structural adjustment programs, Easterly (2003) showed that for the 1980 to 1998 period the IMF and World Bank gave 10 or more adjustment loans to 36 countries however the medium growth rate of income per capita in these countries over the period considered was zero. They also provide evidence that growth under structural adjustment was "less pro-poor" meaning that the poor shared less in economic growth however on the flipside they were also hurt less during periods of contraction. Adedeji (2002) showed that for the 1960 to 1975 period, only 9 sub-Saharan African countries experienced negative growth however following the implementation of structural adjustment programs, 28 countries in the region had negative growth in per capita GDP for the 1975 to 1985 period.

Structural adjustment programs additionally led to increased income inequality (Crisp and Kelly, 1999; Easterly, 2003). Wages fell as a result of deregulation and disease increased due to a fall in government spending on health and other social services (Greer, 2013).

On the question of growth and financial liberalisation, the debate remains unsettled with some researchers finding a positive relationship (Quinn, 1997; Bailliu, 2000) and others finding a negative or no statistically significant relationship (Grilli and Milesi-Ferretti, 1995; Edison et al, 2002). According to Fratzscher and Bussiere (2004), the key reason behind the "elusive" empirical results is the time varying relationship between openness and growth as countries tend to gain in the short term following liberalisation usually resulting from an investment boom and an increase in portfolio and debt inflows. Unfortunately, these effects are temporary as they may lead to over borrowing which eventually leads to economic contraction as the initial bubble bursts leading to financial crisis (McKinnon and Pill, 1997; 1999).

In the medium to long term other factors such as institutional quality and the size of foreign direct investment inflows may affect the level of growth. Evidence in support of this trade-off is found for 45 developed and emerging economies (Fratzscher and Bussiere, 2004). Making use of meta-analysis statistical techniques, Bumann et al (2012) analysed the effect of financial liberalisation on 60 different empirical studies starting in the 1960s. Their results from the systematic analysis of the empirical literature provides evidence that during the 1970s, there was a strong negative relationship between financial liberalisation and economic growth while for the entire period considered, the relationship is positive albeit weak as it is barely significant.

Due to the failures described above, the structural adjustment programs received a lot of criticism resulting in the World Bank and IMF shifting their focus to governance and institutions. As such, from around the late 1980s, there was an increase by these institutions to promote property rights, the rule of law and better public administration and accountability (Greer, 2013). However the new institutionalist approach favoured, continued to promote deregulation and advocate for a reduction in the role of the state in the economy.

2.2.5. The New Institutionalists

Institutions are defined as humanly created constraints that structure economic, political and social interaction. They consist of formal constraints taking the form of constitutions, laws and property rights as well as informal constraints such as sanctions, taboos, customs, traditions and code of conduct. Their purpose is to reduce uncertainty in exchange (North, 1991).

According to North (1991), the incentive structure of an economy is provided by institutions and as that structure evolves, the direction of economic change towards growth, stagnation or decline is shaped. The main difference in the pace and level of economic growth between advanced countries is the nature of institutions.

The new institutional approach takes the market as a natural occurring phenomenon and sees the state as made up of self-seeking individuals who are liable to corruption. They are additionally viewed as being inefficient in collecting information and implementing policies thus leading to government failure. The policy implication therefore is to minimise the role of the state as the cost of government failure outweighs the cost arising from market failure (Chang, 2001).

This is different from the old institutionalist approach which recognises that institutions are made up of individuals who determine who can participate and the rules of the game. As a result, they are susceptible to lobbying from powerful groups who benefit from the current system and therefore oppose institutional change (Chang, 2001). State intervention is seen as a powerful medium to bring about institutional change.

Some insights of the new institutionalist approach gained popularity following the failure of structural adjustment programs largely implemented by international financial institutions under the neoclassical/neoliberal doctrine, to bring about economic development. The World Bank and IMF have identified weak institutions and poor governance as the main reason for the failure in achieving economic development in many underdeveloped countries (World Bank, 1992 and Poverty Reduction and Economic Management Network, 2000).

Using data for 1995 GDP per capita and a broad measure for property rights as a measure for economic institutions averaged over the period 1985 to 1995, Acemoglu et al (2004) show that countries with better economic institutions have higher average incomes. They do however identify the problem related to measuring institutions as they are multifaceted. A study by the World Bank (2013a) analysed the existing literature relating institutions to poverty reduction, finding that the evidence on the relationship between the two was limited and inconclusive. Many heterodox economic schools, particularly the big push and balanced growth advocates, have argued that more is needed to bring about economic growth.

2.3. Concluding Remarks

Modern growth theory, defined as a continuous increase (decrease) on the equilibrium of one of the components in the system, began with Harrod (1939). He introduced three growth rates; the actual rate of growth, the warranted rate of growth and the natural rate of growth. In the Harrod (1939) model, there is no mechanism to ensure that plans to save equal plans to invest, thus the system is highly unstable and tends towards disequilibrium. There are buffers to this divergence, with the upper buffer being the natural rate of growth for in the long run, the system cannot operate above the full employment ceiling. The Harrod (1939) model led to the "great debate" on economic growth.

Full employment of labour and capital requires equality between the three growth rates ($G = G_w = G_n$). The relationship between the actual rate of growth and the warranted rate of growth captures the trade cycle, hence most of the debate focused on reconciling the warranted rate of growth and the natural rate of growth. During the early debate, both the neoclassical and Keynesian school treated the natural rate of growth as exogenous. An adjustment to the endogenously determined warranted rate of growth therefore reconciled the two. In both approaches, the "knife edge" unstable equilibrium described by Harrod (1939) is not supported.

The neoclassical and Keynesian school differed in their approach to the adjustment mechanism that reconciled the warranted rate of growth to the natural rate of growth. For the neoclassical school, the adjustment takes place through changes in the capital output ratio through the substitution of capital and labour. This of course depends on fully flexible prices. For the Keynesian school, the adjustment takes place through changes in the savings ratio, taken as a function of income distribution between wages and profits. The propensity to save out of profits is assumed to be higher than wages. As the debate advanced, the Keynesian school treated the natural rate of growth as endogenous to the system.

Growth in labour productivity (Kaldor, 1957) and growth in the labour force (Leon-Ledesma and Thirlwall, 2002) were theoretically proven to be endogenous. For the former, this is best explained by Verdoorn's law which relates growth in output to increases in productivity due to static, dynamic and macro increasing returns (Kaldor, 1967). For the latter, growth in the labour force is treated as derived demand responding to changes in the actual rate of growth.

In the post-Keynesian school, equilibrium growth is therefore achieved through an adjustment in the warranted and natural rate of growth. This has consequences for the model, for it means that the full employment ceiling, within limits, shifts in response to changes in the actual rate of growth. It therefore becomes illogical to think of growth in terms of the exogenously determined production frontier as done in the neoclassical model. The production frontier instead shifts with each movement in the actual rate of growth (Thirlwall, 2013).

Several studies have been carried out to test if the natural rate of growth is endogenous to the actual rate of growth for the OECD (Leon-Ledesma and Thirlwall, 2002; Lanzafame, 2014), Latin America (Libanio, 2009; Vogel, 2009) and a selection of Asian countries (Dray and Thirlwall, 2011). No studies have yet been carried out for low income countries or for the sub-Saharan African region. Empirically testing the role of demand for economic growth in the region is important rather than simply assuming, as has been done in the past by neoclassical economics, that demand is irrelevant for long run growth.

The Harrod (1939) model as well as the Solow (1956) and Kaldor (1956; 1957) respective responses outlined, are models representing a closed economy. In order to fully understand the growth performance of countries, an open economy model is needed. Within the Keynesian literature, the dominant constraint to long run growth in an open economy is the balance of payments constraint (Thirlwall and Dixon, 1979; Thirlwall, 2001; Lanzafame, 2014).

Thirlwall (2001) extended the Harrod (1939) model to an open economy model and theoretically showed that the balance of payments equilibrium growth rate is the long run constraint to growth. Lanzafame (2014) empirically verified the theoretical expectations for 22 OECD countries. The other Keynesian open economy growth model is the export-led cumulative causation model (Kaldor, 1970). When empirically tested, the model over predicted the actual rate of growth (Dixon and Thirlwall, 1975). Model performance greatly improved when a balance of payments constraint was added for in the long run, a country cannot advance faster than the latter.

The balance of payments constrained growth model has been tested extensively for developed countries with the results generally giving support to it[22]. It has also been tested for several developing countries particularly in Latin America and Asia (Alvarez-Ude and Gomez, 2008; Bertola et al, 2002; Britto and McCombie, 2009; Moreno-Brid, 2003; Razmi, 2005; Felipe et al, 2010; Tharnpanich and McCombie, 2013). There is very little empirical research regarding the

[22] See McCombie and Thirlwall (2004) for a survey of the literature up to 2003.

relevance of the balance of payments constraint for sub-Saharan Africa. The few studies that do exist on the region verify the theoretical expectations of the model (Hussain, 1999; Nell, 2003; Perraton, 2003).

The last comprehensive study on the balance of payments constrained model for the African region was done by Hussain (1999) using data covering the period 1970 to 1990. However although acceptable at the time, the study made use of OLS without pre testing the data for stationarity. The results may be spurious and therefore invalid. Perraton (2003), using data for the 1973 to 1995 period, applied more appropriate estimation techniques to test the relevance of the model for a group of developing countries; 12 and 7 sub-Saharan African countries were included for the weak and strong form of Thirlwall's law respectively.

Both Hussain (1999) and Perraton (2003) did not accommodate for sustainable debt accumulation and interest rate payments abroad. Moreno-Brid (2003) has theoretically and empirically shown that sustainable debt accumulation can be incorporated into the model by imposing a long term constraint where the ratio of the current account deficit to income is constant.

Testing the relevance of the extended model which incorporates sustainable debt accumulation, interest rate payments and the terms of trade is necessary as many of the countries within the region are heavily indebted poor countries (World Bank, 2015). In addition, majority of the countries depend on the production of primary products in international markets making the terms of trade effects more pronounced. An empirical study for the sub-Saharan African region that uses the above extended version of the model, applying recent data and more appropriate econometric techniques is warranted.

The application of a demand-led growth model is further motivated by the failure of supply side growth models, which have dominated economics in the region, to explain growth rate differences between countries. The Solow (1956) model, based on the crucial and unrealistic assumptions of identical savings rates, population growth and technology across countries, predicts convergence between rich and poor countries as the latter grow faster than the former as they accumulate capital. Although observed for some OECD countries, there is no evidence of convergence for the world as a whole (De Long, 1988; Jones, 2002). This has spurred an empirical body of literature which controls for other factors influencing the growth of per capita income. These studies provide some evidence in favour of conditional convergence (Barro, 1991; Mankiw et al, 1992; Barro and Lee, 1993).

The new endogenous growth models are different from the neoclassical model as they endogenise technological change. However just as in the neoclassical model, supply is assumed to create its own demand making demand irrelevant for long run growth. Keynes (1936) showed that it is only in the special case of full employment that Say's law applies. Under the assumption of constant technological change, the Romer (1990) model is reduced to the Solow (1956) model.

Economic development has become synonymous with structural transformation, defined as the movement of labour from the agricultural sector to industry and services. The Keynesian literature identifies the causal relationship between growth in the manufacturing sector and growth in output as the sector is characterised by increasing returns to scale (Kaldor, 1966). Supply side models however are sector indifferent[23]. This is with the exception of the Lewis (1954) model, however development relies on an increase in functional inequality requiring the profit share in GDP to increase as the economy develops. There is a large and growing body of literature on the negative relationship between inequality and growth (Alesina and Perotti, 1996; Ravallion, 1997; Banerjee and Duflo, 2003; Bourguignon, 2003; Chambers and Krause, 2010; Malinen, 2012).

As a result of this sector indifference, it is not surprising that supply-led models have performed poorly in explaining growth rate differences across countries. This includes the models of international trade based on comparative advantage as the empirical literature remains inconclusive on the effects of globalisation and neoliberal policies on economic growth (Bumann et al, 2012). Comparative advantage may be the result of differences in productivity between countries as in the Ricardian model (1815) or it may be the result of differences in relative factor endowments. Either way, the model predicts specialisation between countries producing goods for which they hold a "natural or artificial" comparative advantage.

Following liberalisation policies from the late 1970s onwards, mainly implemented in developing countries through loan conditionality and structural adjustment programs initiated by the World Bank and IMF, developing countries in "conforming" to their comparative advantage, have found themselves left specialising in the production of agricultural products and other raw materials. As argued by the Institutionalist Political Economy, in order to achieve sustainable economic growth and development, developing countries need to "defy" their comparative advantage, by building new capabilities in the production of products with higher productivity requirements.

Latin American Structuralism also highlight the dangers of specialising in the production of primary/agricultural products for over time, the terms of trade turn against the latter in favour of manufactured products (Prebisch, 1950; Singer, 1950).

[23] In new endogenous growth models, the research sector is identified as leading innovation however the manufacturing sector, as done in heterodox models, is not identified as the engine for growth.

Other heterodox growth theories, alongside Latin American Structuralism, that have been influential in the region are the big push (Rosenstein-Rodan, 1943; Nurkse, 1953; Fleming, 1955; Murphy et al, 1989) and balanced growth models (Hirschman, 1984). These models advocated for large scale planned industrialisation in depressed world regions as a way of raising incomes. International investment based on capital lending and investment are recognised as important sources of finance.

One of the implications from the balance of payments constrained growth model, is that the structure of production matters as it determines the income elasticity of demand for exports and imports. Applying the model to the sub-Saharan African region, may help shed light on how structural change can be achieved to bring about sustainable growth and development. As the balance of payments constrained growth model is a demand-led model, it is important to first empirically test the relevance of demand for the region. This is done in chapter 4.

3. BACKGROUND CHAPTER

The background chapter is developed in order to understand the growth experience of the sub-Saharan African region in the post-colonial period[24]. While it is possible to group countries based on their levels of income, like the World Bank categorises low to high income countries, this is insufficient as these categories do not take into account inequality, poverty levels and other important indicators.

We present data on all 31 sub-Saharan African countries included in the research however we focus on 7 of the largest based on population size and the level of GDP[25]. These countries are South Africa, Nigeria, Angola, Sudan, Kenya, Tanzania and Ethiopia. Together they account for over 50% of the population and 68.5% of the regions GDP.

The chapter covers key development statistics, labour market indicators, the sectoral composition of employment and production as well as international trade statistics.

3.1. Key Development Indicators

The annual growth rate for sub-Saharan Africa in comparison to other world regions and the world average is shown in Figure 3.1. For the 1976 to 1999 period, growth performance in the region was on average below the world growth rate. However, since 2000, growth in sub-Saharan Africa has been above the world average. Growth in the region has persistently outperformed Latin America and the Caribbean, the Middle East and North Africa, North America and Europe and Central Asia.

[24] Many African countries gained independence from colonial rule from the late 1950s to mid-1970s.
[25] Countries ranked based on a weighted average for total population and GDP, 2012 estimates in constant 2005 USD (World Bank, 2016).

Figure 3.1a; Annual GDP growth, % for sub-Saharan Africa and the world

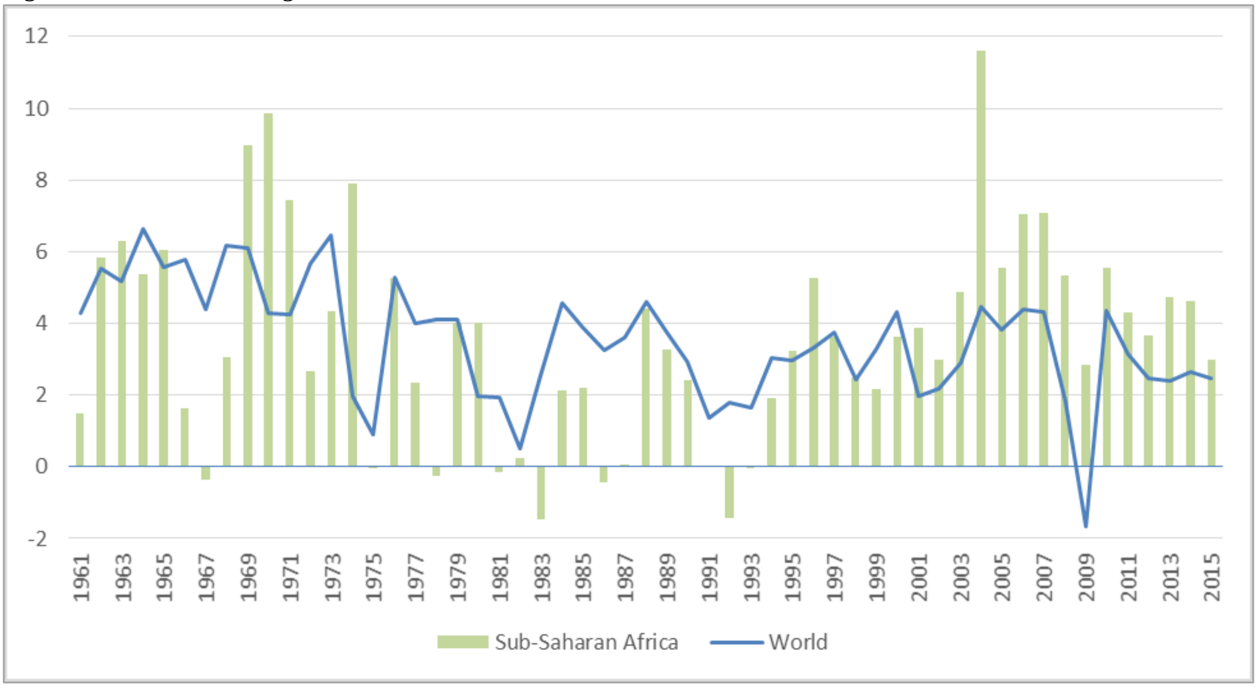
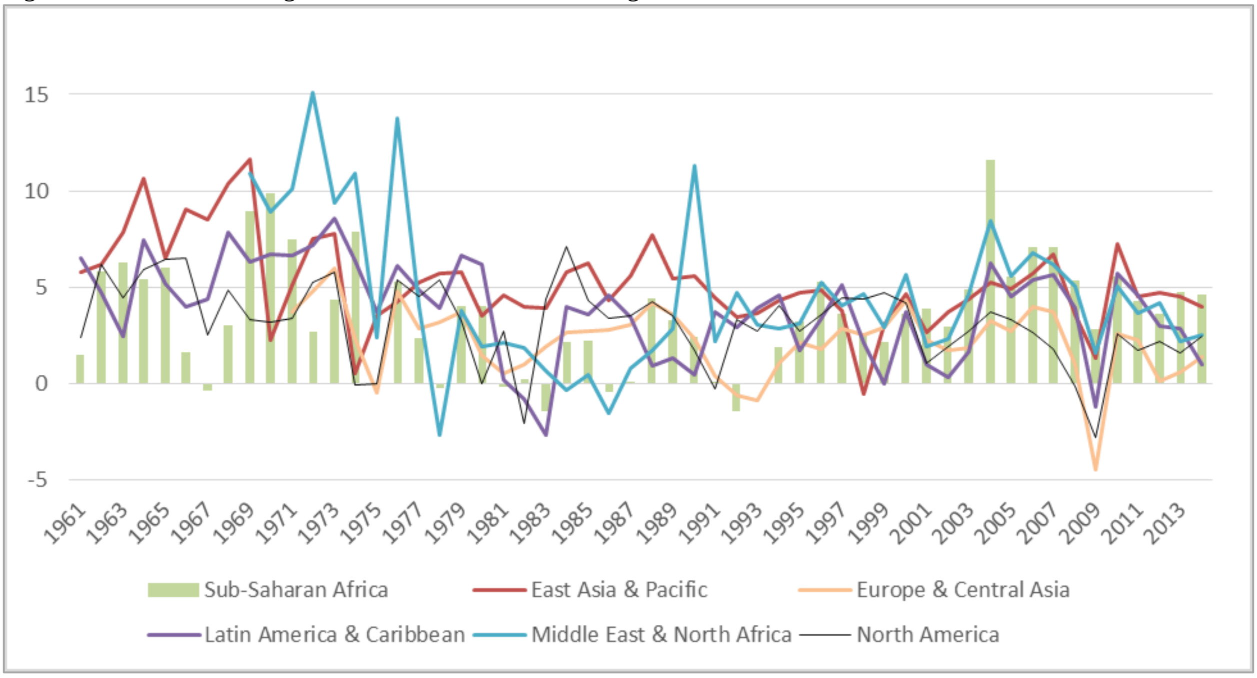
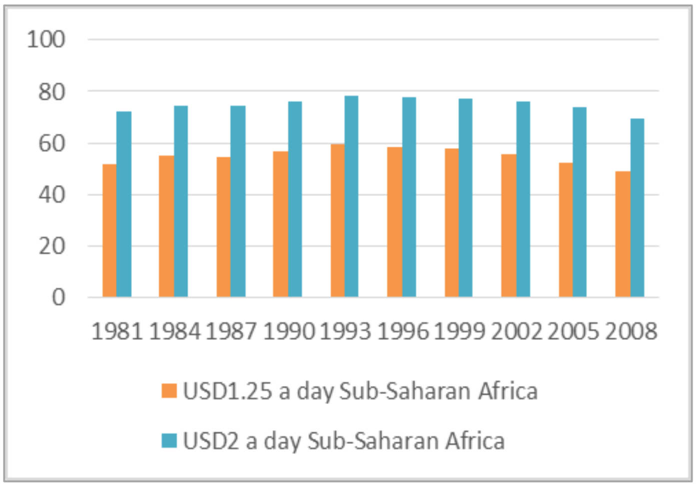


Figure 3.1b; Annual GDP growth, % for different world regions



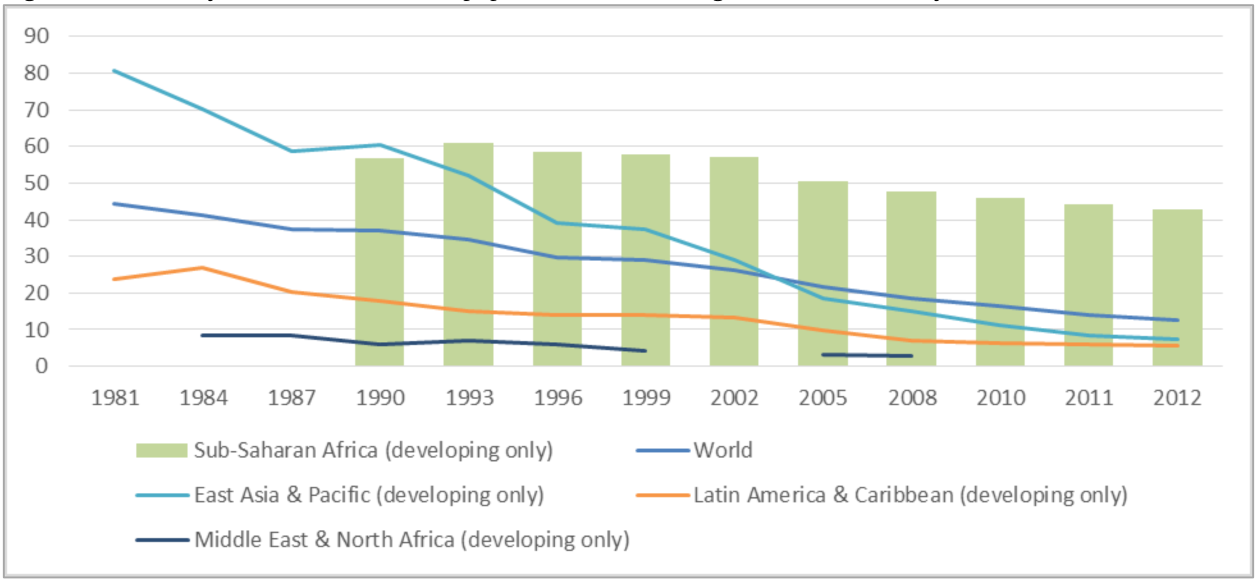
Source: World Bank (2016)

Figure 3.2a; Poverty headcount ratio, % of population



Despite the high growth rates experienced in the region, poverty measured at the 2USD a day poverty line has remained persistently high standing at 69.2% in 2008. From Figure 3.2, it is clear that sub-Saharan Africa is the only region that has failed to significantly reduce poverty levels. In 1990, the developing countries of East Asia and the Pacific had higher rates of poverty than sub-Saharan Africa however by 2012 they were able to reduce the level of poverty to 7.2%. The developing countries of Latin America, the Middle East and North Africa reduced poverty levels to below 6%.

Figure 3.2b; Poverty headcount ratio, % of population for world regions, USD1.90 a day



Source: World Bank (2016)

Inequality is believed to reduce the elasticity of poverty to economic growth (Easterly, 2003). Table 3.1 shows the Gini index for the 1970 to 2010 period. Although inequality was reduced overall in most African countries, it increased in Angola, Central African Republic, Republic of Congo, Ethiopia, Gambia, Ghana, Mozambique, Rwanda, Togo and Uganda. These countries account for 25% of the total population in the region.

Countries experiencing the largest increase in inequality were Rwanda with 102%, Uganda with 19.2%, Ghana with 18.5% and Angola with 18.1%. The fall in equality in the rest of the countries ranged from 0.2% for Chad to 36.7% for Kenya. From Figure 3.3 it is clear that southern Africa has some of the highest levels of inequality in the world.

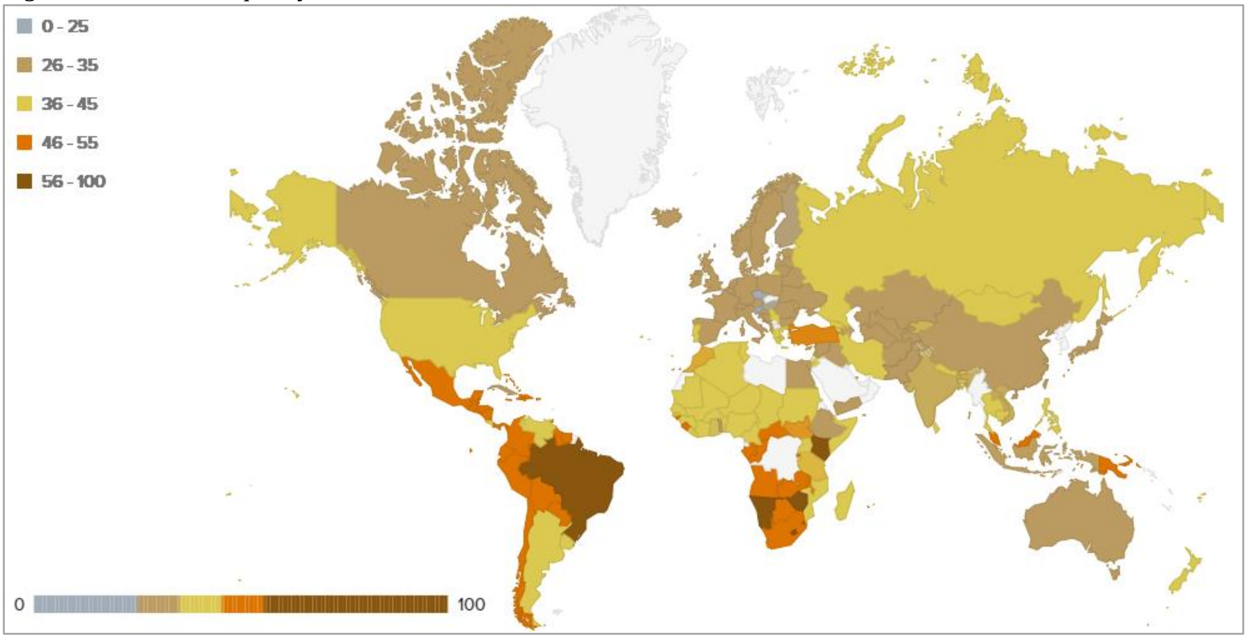
Table 3.1; Inequality in sub-Saharan Africa, Gini Index, 1970 to 2010

Country	Gini Net	Gini Net	% Change	Start Date	End Date
Angola	39.7	46.9	18.1%	1995	2009
Benin	36.2	35.4	-2.2%	2003	2006
Botswana	55.4	51.8	-6.5%	1971	2005
Burkina Faso	42.8	38.8	-9.5%	1994	2009
Burundi	32.8	32.6	-0.7%	1992	2006
Cameroon	47.6	37.8	-20.7%	1983	2007
Central African Rep.	55.6	55.8	0.2%	1992	2008
Chad	38.9	38.8	-0.2%	2002	2005
Congo, Dem. Rep.	42.1	41.9	-0.5%	2005	2006
Congo, Rep.	41.9	42.8	2.0%	2005	2006
Ethiopia	31.8	33.0	3.6%	1981	2010
Gabon	57.4	40.6	-29.3%	1975	2005
Gambia	42.2	47.6	12.9%	1992	2003
Ghana	33.9	40.2	18.5%	1987	2006
Kenya	69.4	43.9	-36.7%	1971	2007
Malawi	49.6	43.0	-13.2%	1977	2010
Mali	36.1	32.6	-9.7%	1989	2010
Mauritius	39.5	38.3	-3.0%	1975	2006
Mozambique	40.4	43.0	6.5%	1996	2008
Namibia	66.6	58.4	-12.3%	1993	2010
Nigeria	50.8	43.4	-14.5%	1970	2010
Rwanda	23.7	47.8	101.9%	1985	2010
Senegal	40.9	38.0	-7.2%	1970	2010
Sierra Leone	41.1	36.2	-12.0%	1976	2010
South Africa	62.9	59.4	-5.5%	1975	2010
Sudan	43.7	34.6	-20.8	1968	2009
Swaziland	53.8	49.9	-7.3%	1974	2009
Tanzania	46.7	37.1	-20.5%	1977	2007
Togo	33.7	37.5	11.4%	2005	2010
Uganda	34.8	41.5	19.2%	1970	2010
Zambia	58.9	57.0	-3.3%	1970	2010
Zimbabwe	52.3	51.5	-1.5%	1990	2010

Note: % change is measured as ((Gini at end – Gini at start)/Gini at start*100)

Source: Solt (2014)

Figure 3.3; Global inequality, Gini coefficient

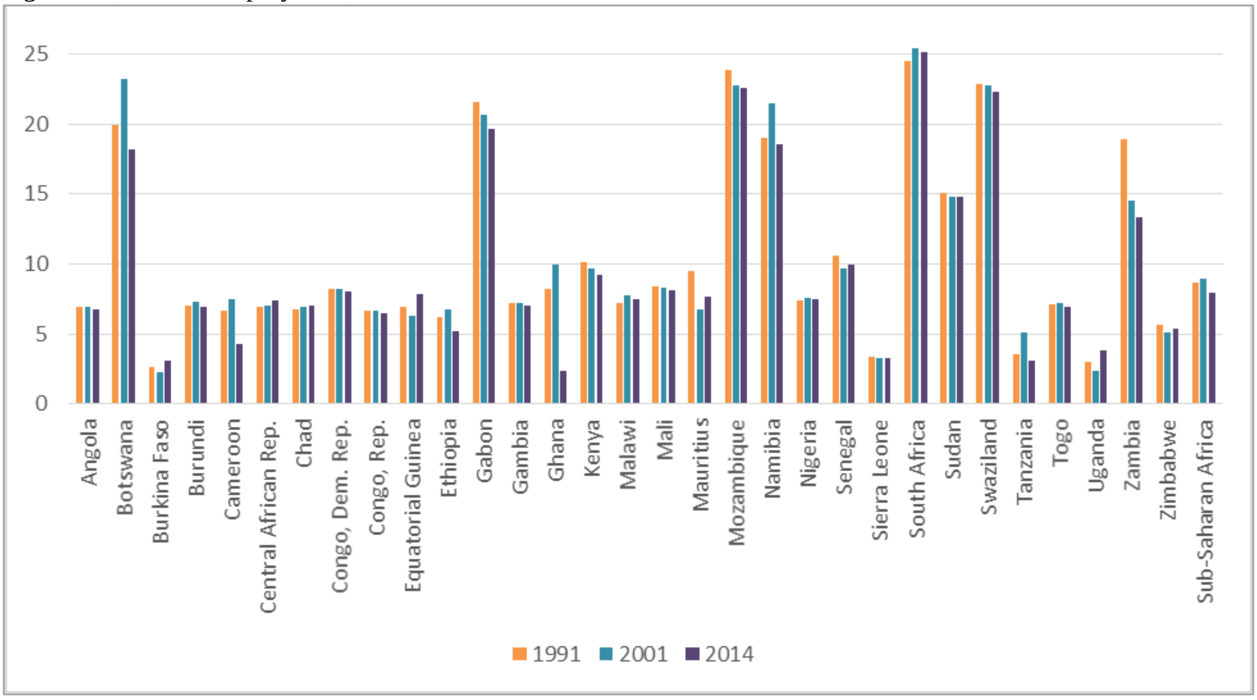


Source: United Nations University World Institute for Development Economics Research (2016)

3.2. Labour Market Indicators

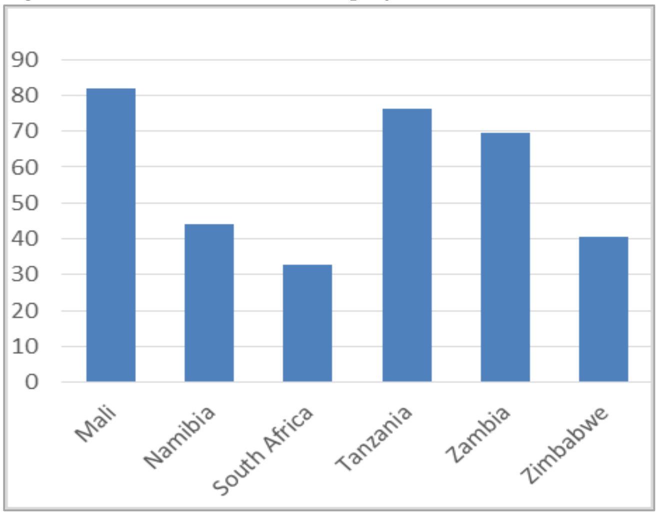
Unemployment in the sub-Saharan region averaged 8% in 2014 as seen in Figure 3.4. For the majority of the 31 countries included in our analysis, official unemployment rates were below 10%. In 2014, South Africa had the highest unemployment rate of 25.1% followed by Swaziland with 22.3% and Mozambique with 22.6%. These figures do not account for the type or quality of employment.

Figure 3.4; Total unemployment, % of the labour force



Source: ILO estimates, World Bank (2016)

Figure 3.5; Share of informal employees, % 2004 to 2014

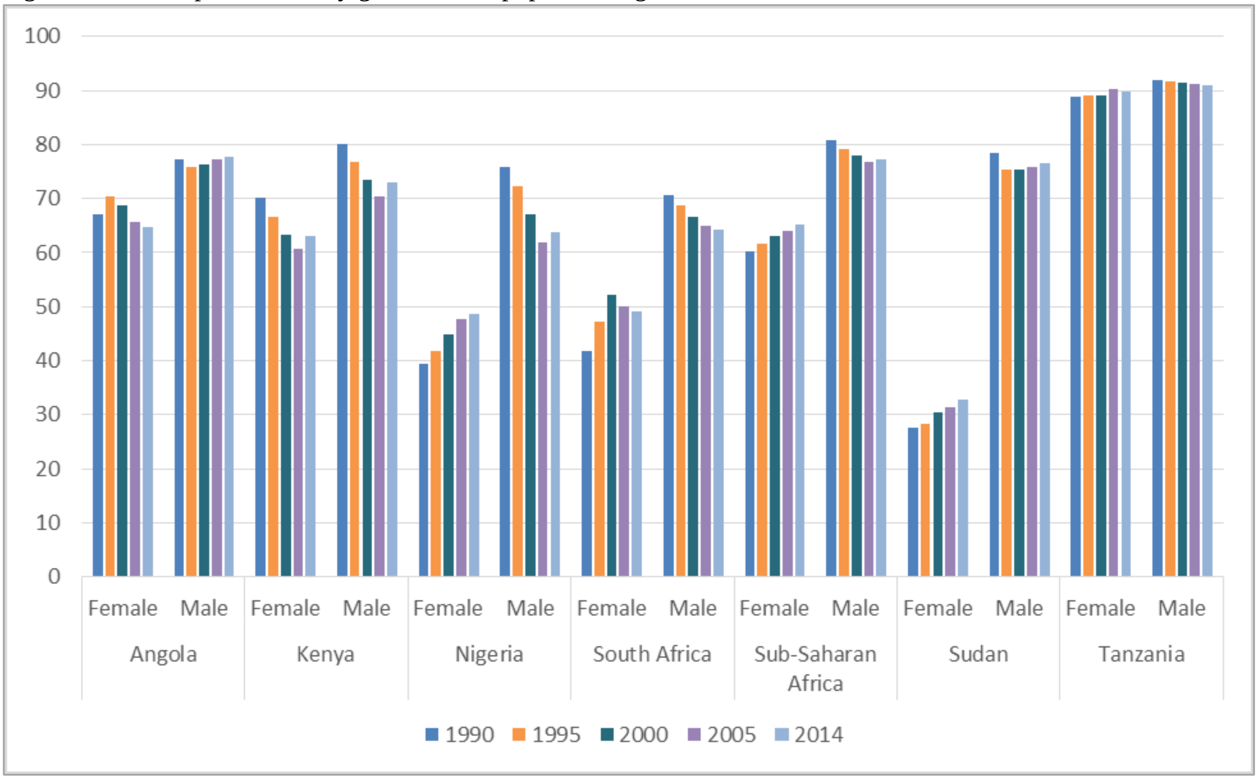


Source: World Bank (2016)

The informal sector in sub-Saharan Africa is huge and accounts for over 80% of the labour force (United Nations Economic Commission for Africa, 2015). Figure 3.5 shows statistics on informal employment in non-agricultural employment. Due to poor data availability, we only have information on 6 sub-Saharan African countries. Informal employment ranged from 32.7% in South Africa to 81.8% in Mali.

For the region as a whole, labour force participation rates are higher for males compared to females. Figure 3.6 shows participation rates by gender for the 7 largest economies in the region. The largest gap in participation rates is observed for Sudan where male participation rates are 43.8 percentage points higher.

Figure 3.6; Participation rates by gender, % of population aged 15 to 64



Source: ILO estimates, World Bank (2016)

3.3. Sectoral Composition of Employment and Output

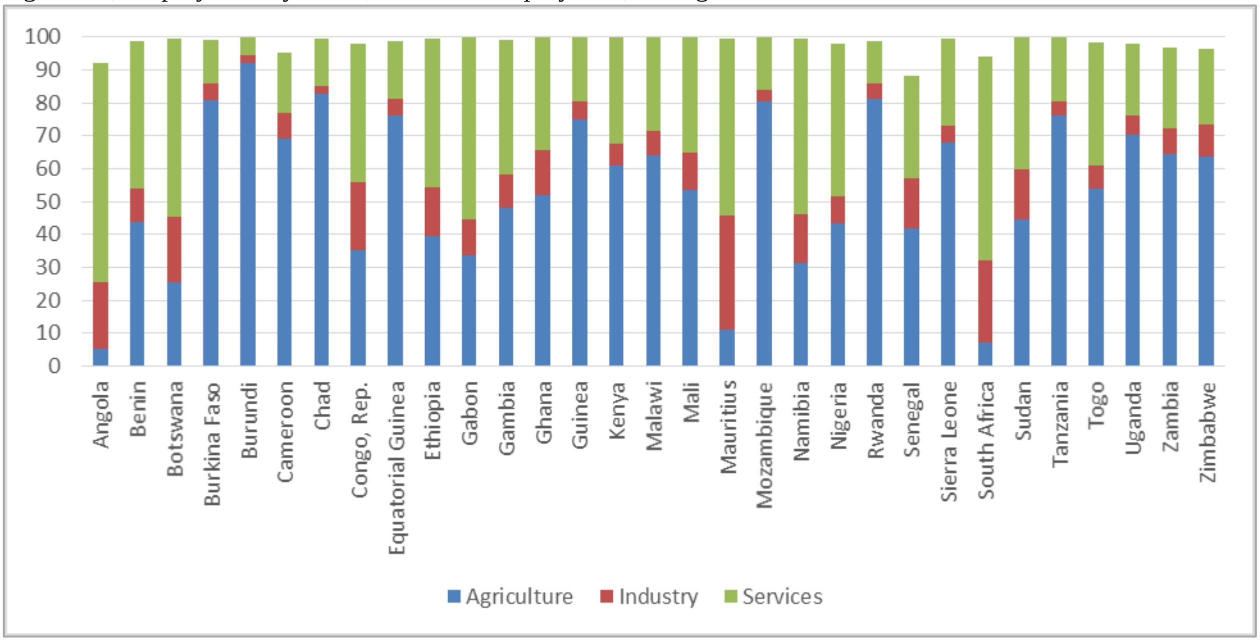
The average employment by sector for the 1980 to 2014 period is given in Figure 3.7. The majority of the labour force in sub-Saharan Africa is employed in the agricultural sector which accounts for over 80% of employment in Burkina Faso, Burundi, Chad, Mozambique and Rwanda. This is followed by employment in the service sector. In all countries included in the analysis, industry accounts for the smallest share of employment. For Burundi, Chad and Mozambique, industry accounts for just 2.2%, 2% and 3.4% respectively.

This is at odds with expectations from the Kaldor (1966) model of economic development. During the early stage of development, we expect most of the labour force to be employed in the agricultural sector, however as a country develops, we expect more labour to be absorbed into industry. Only after a certain level of development or income per capita has been attained, is labour expected to move into the service sector.

According to Tregenna (2015) following liberalisation policies implemented through structural adjustment programs in the 1980s, sub-Saharan Africa experienced "premature deindustrialisation," defined as a fall in employment in industry before a certain level of income per capita is reached.

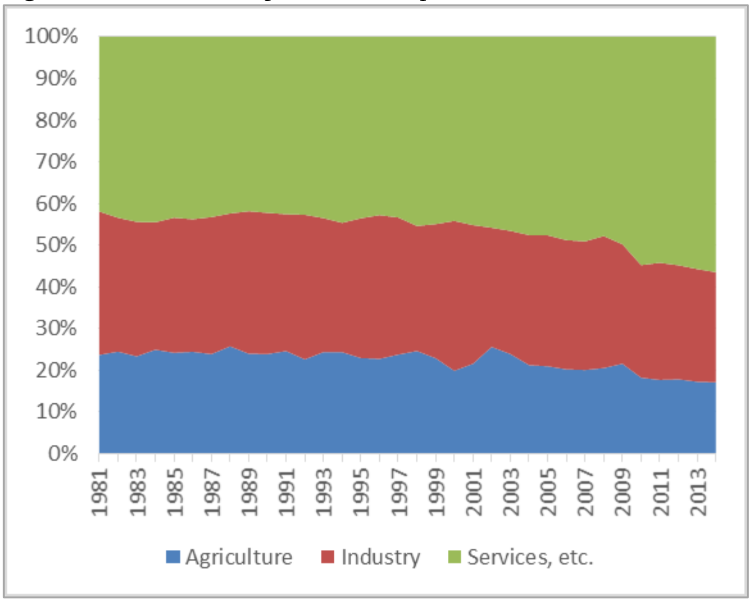
For certain countries in sub-Saharan Africa, employment in the service sector is large relative to their level of development. For Angola, Benin, Botswana, Republic of Congo, Ethiopia, Gabon, Mauritius, Namibia, Nigeria and South Africa, the service sector employs most of the labour force. Angola, Gabon, the Republic of Congo and Nigeria are oil exporting countries. Dutch disease may therefore have contributed to the sectoral composition of labour in the region.

Figure 3.7; Employment by sector, % of total employment, average 1980 to 2014



Source: World Bank (2016)

Figure 3.8; Sectoral composition of output, % of GDP

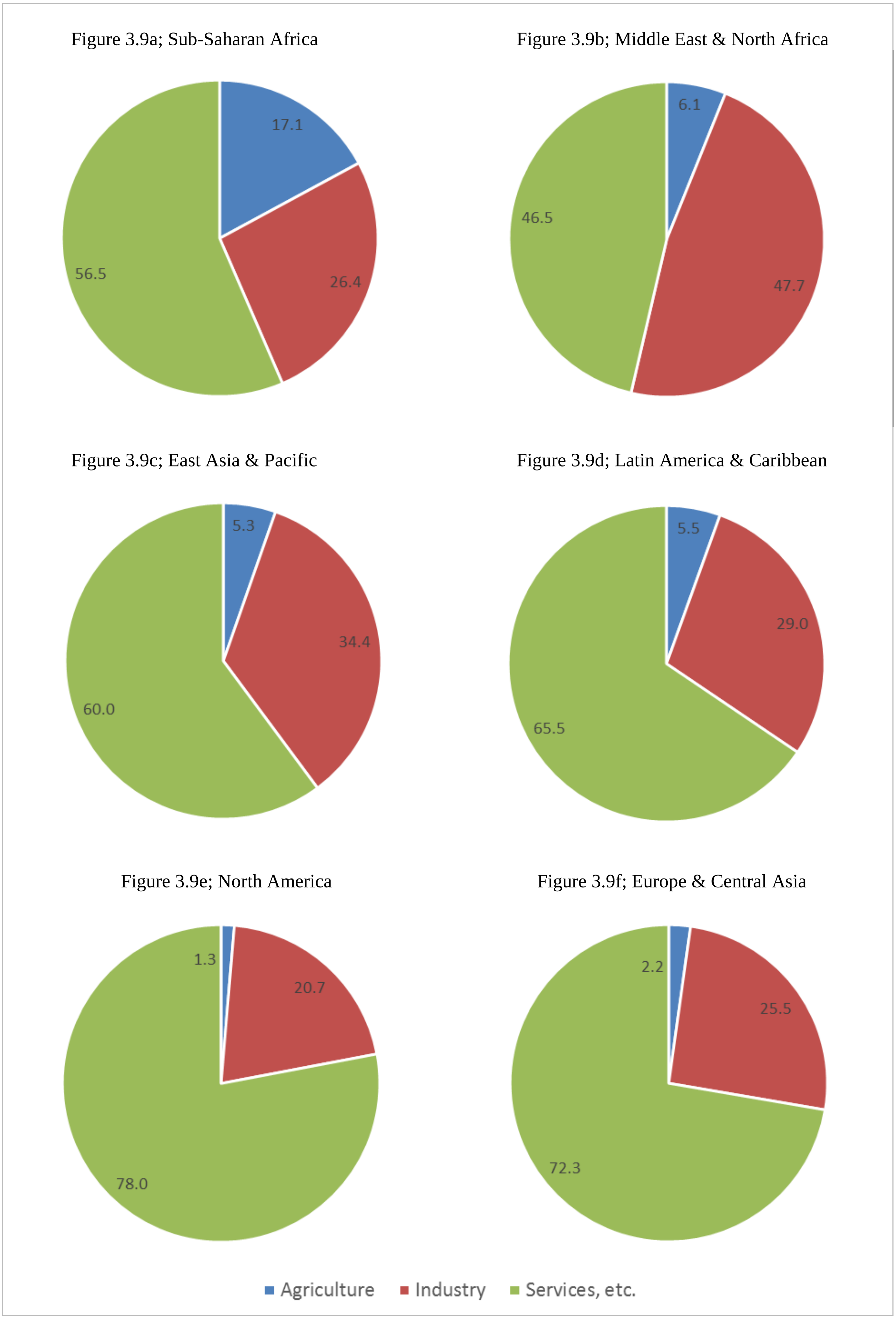


Source: World Bank (2016)

Data on the sectoral composition of output is available from 1981. A summary of the data for sub-Saharan Africa is shown in Figure 3.8. Over the last three decades, the contribution of agriculture and industry has decreased by -6.8 and -8.4 percentage points respectively, while services has increased by 14 percentage points. In relative terms this is a decrease of -28.6% for agriculture, -24.2% for industry and an increase of 33.1% for services.

Figure 3.9 compares the sectoral composition of output for Africa to other world regions. Sub-Saharan Africa has the largest share of agriculture in output, compared to other word regions. In addition, the region has the smallest share of industry in total output compared to other developing regions.

Figure 3.9; Value added output per sector by region; % of GDP 2014

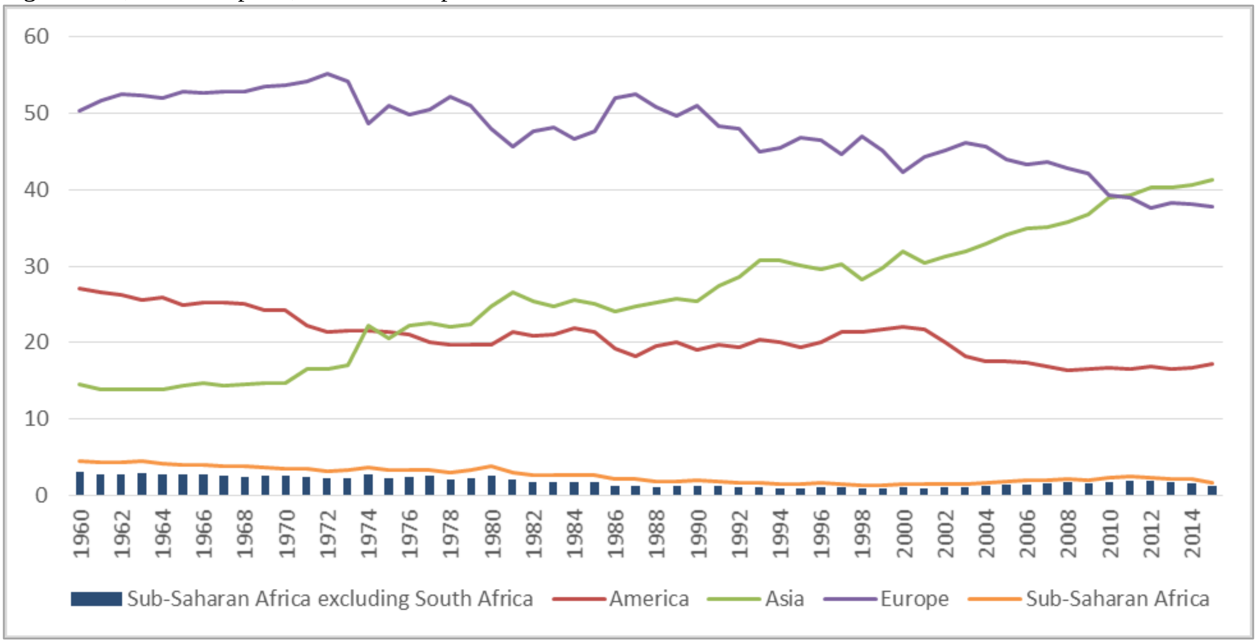


Source: World Bank (2016)

3.4. International Trade

In 2014, sub-Saharan Africa contributed 1.7% to total world trade. The figure is less, at 1.2% when South Africa is excluded. This is substantially lower than its value of 4.5% in 1960. In 2011, Asia surpassed Europe to be the largest world exporter.

Figure 3.10; World exports, % of total exports



Source: United Nations Conference on Trade and Development (2016)

In 2014, intra-regional trade was 62% for the EU, 47.9% for Eastern, Southern and South-Eastern Asia, 16% for South and Central America and 18.2% for sub-Saharan Africa. Excluding South Africa, intra-regional trade for 2014 was just 9.9% for sub-Saharan Africa, the lowest figure observed compared to other world regions. While the absolute value in regional trade has increased substantially for Eastern, Southern and South-Eastern Asia, it has remained stagnant in sub-Saharan Africa.

Figure 3.11a; Intra-trade for world regions, % of total trade

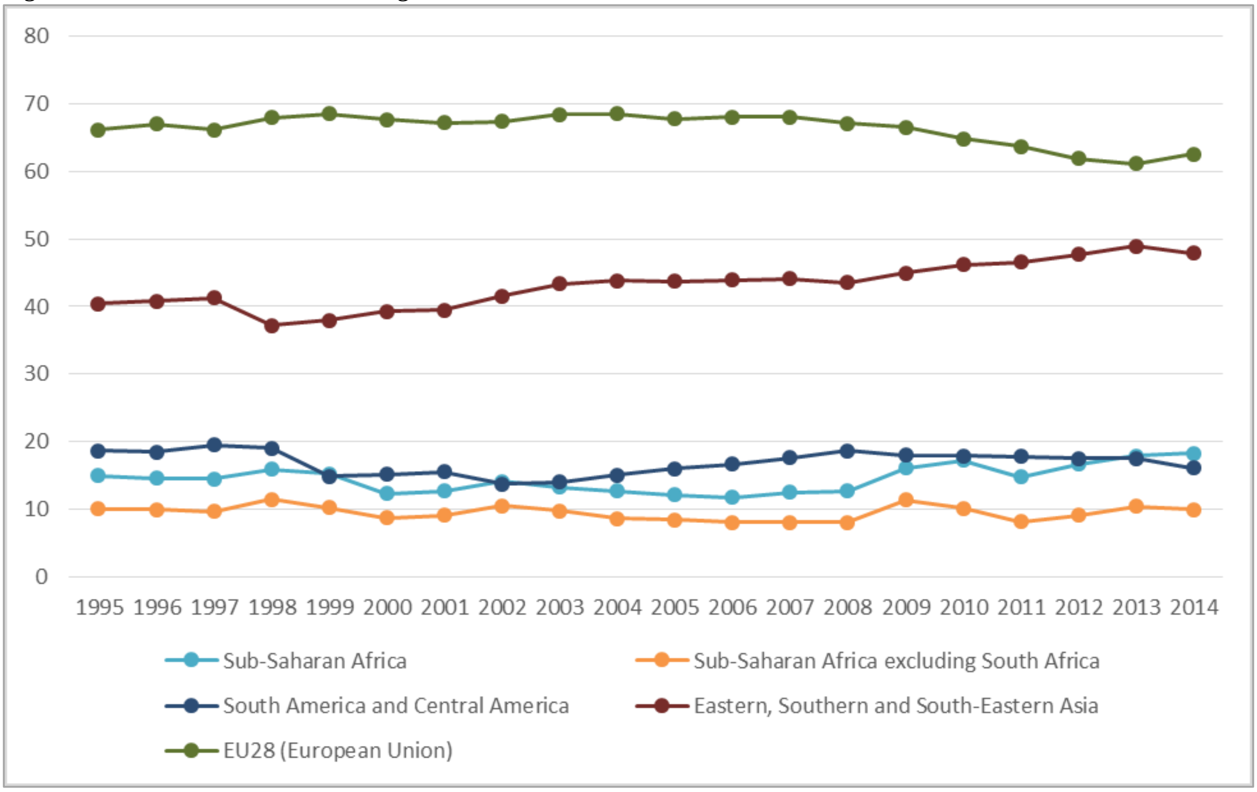
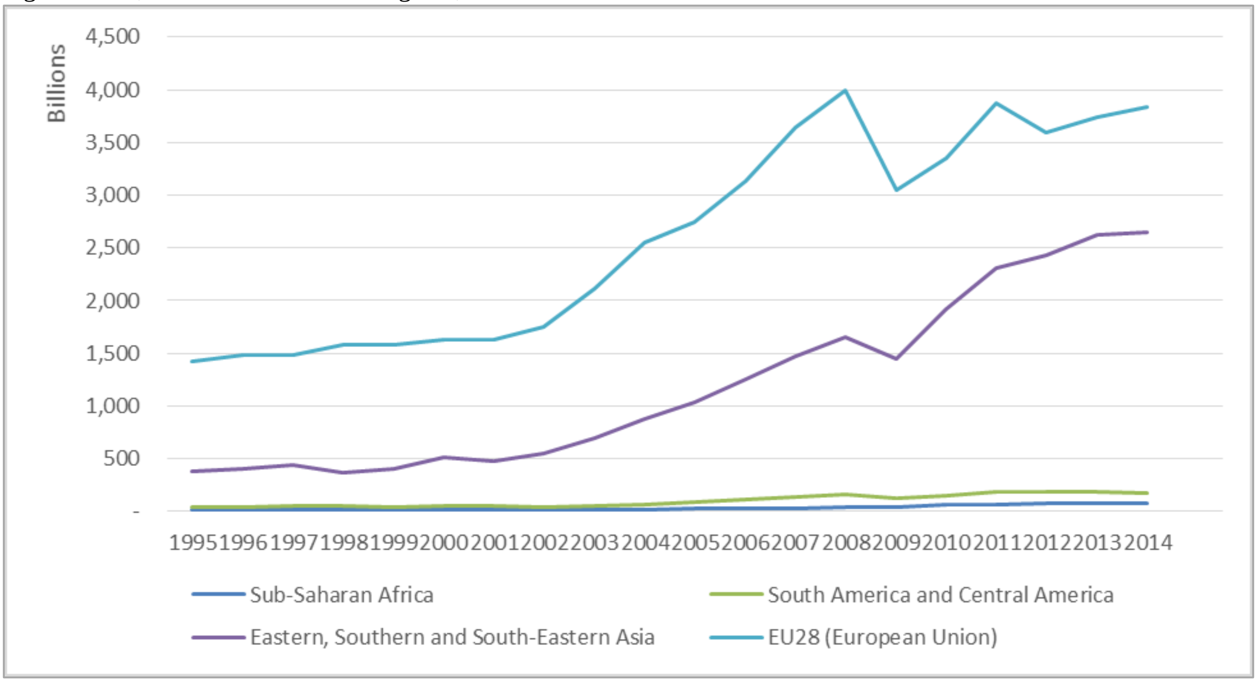


Figure 3.11b; Intra-trade for world regions, USD



Source: United Nations Conference on Trade and Development (2016)

African countries are heavily dependent on the export of primary goods. Figure 3.12 shows the rapid growth in the export of primary products since 2000. Over 75% of sub-Saharan African exports are primary products or resource based manufactures. This is in contrast to Eastern, Southern and South-Eastern Asia whose export of the latter category of goods account for roughly 20% of exports while low, medium and high technology manufactured goods account for the bulk of exports.

Figure 3.12a; Export composition sub-Saharan Africa, Lall classifications, USD

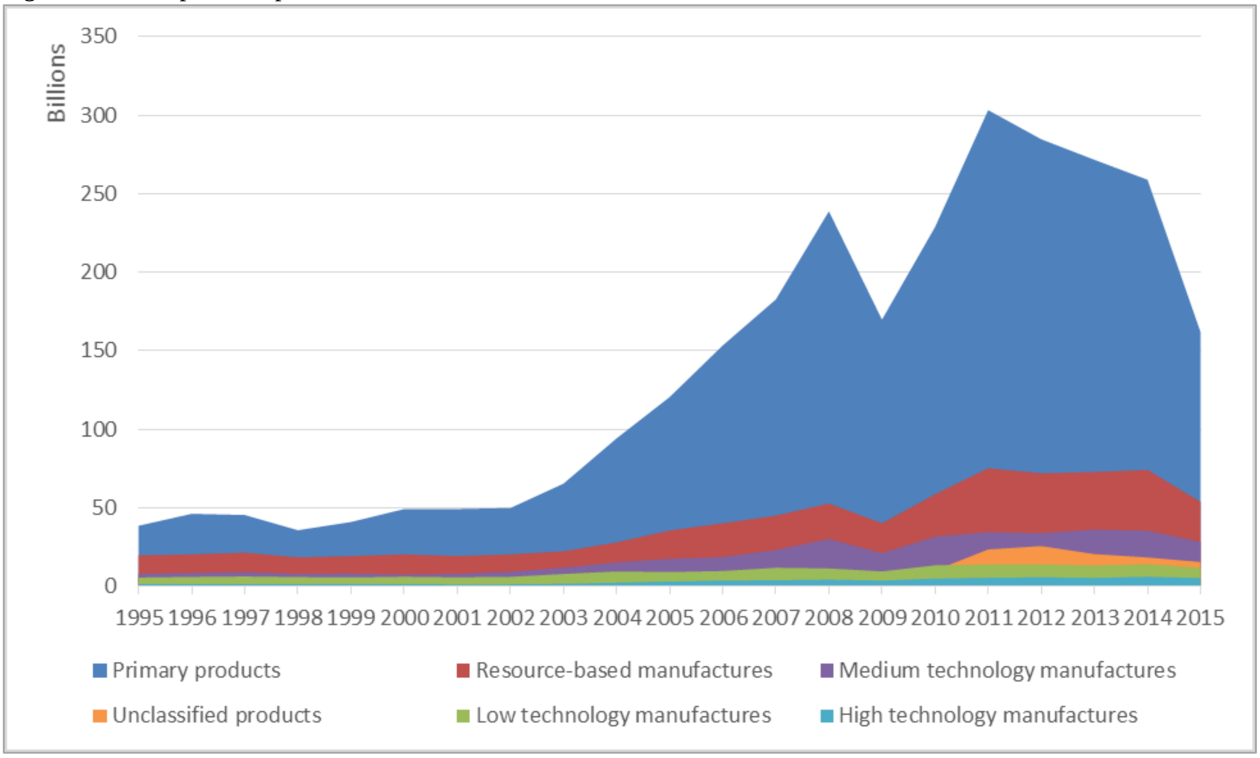
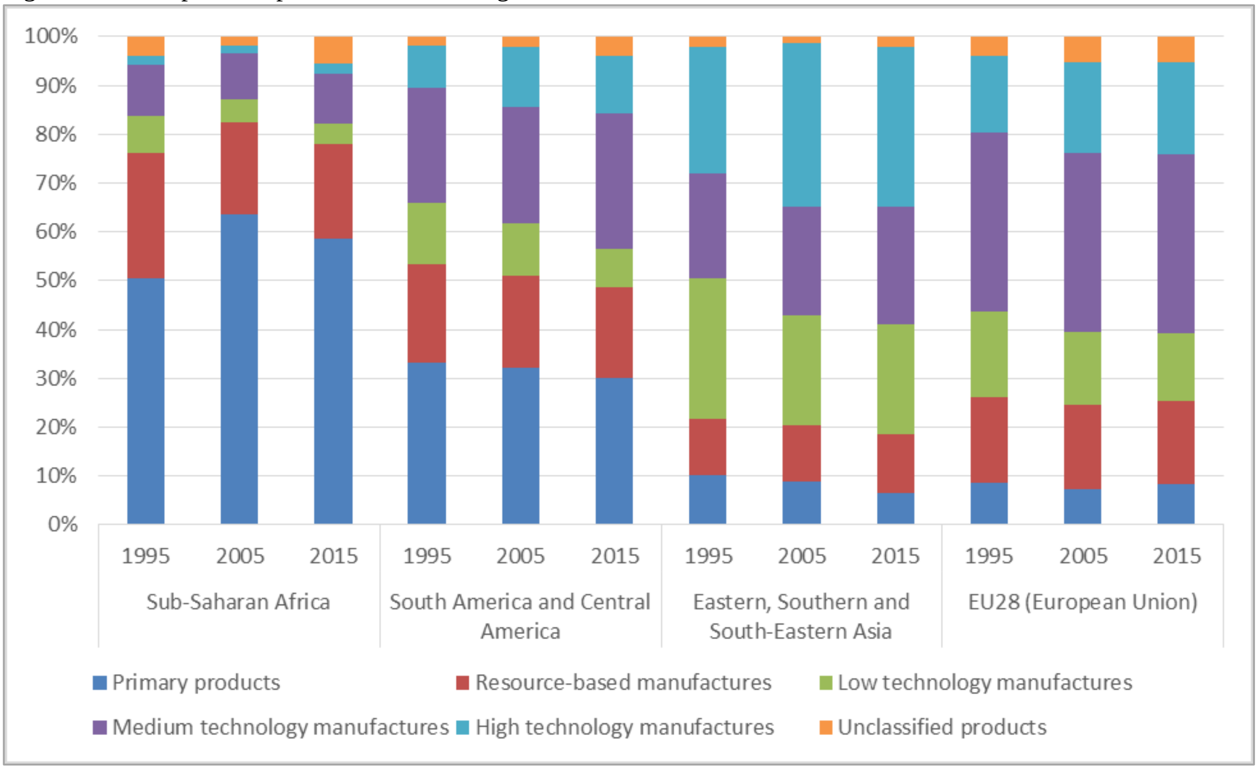


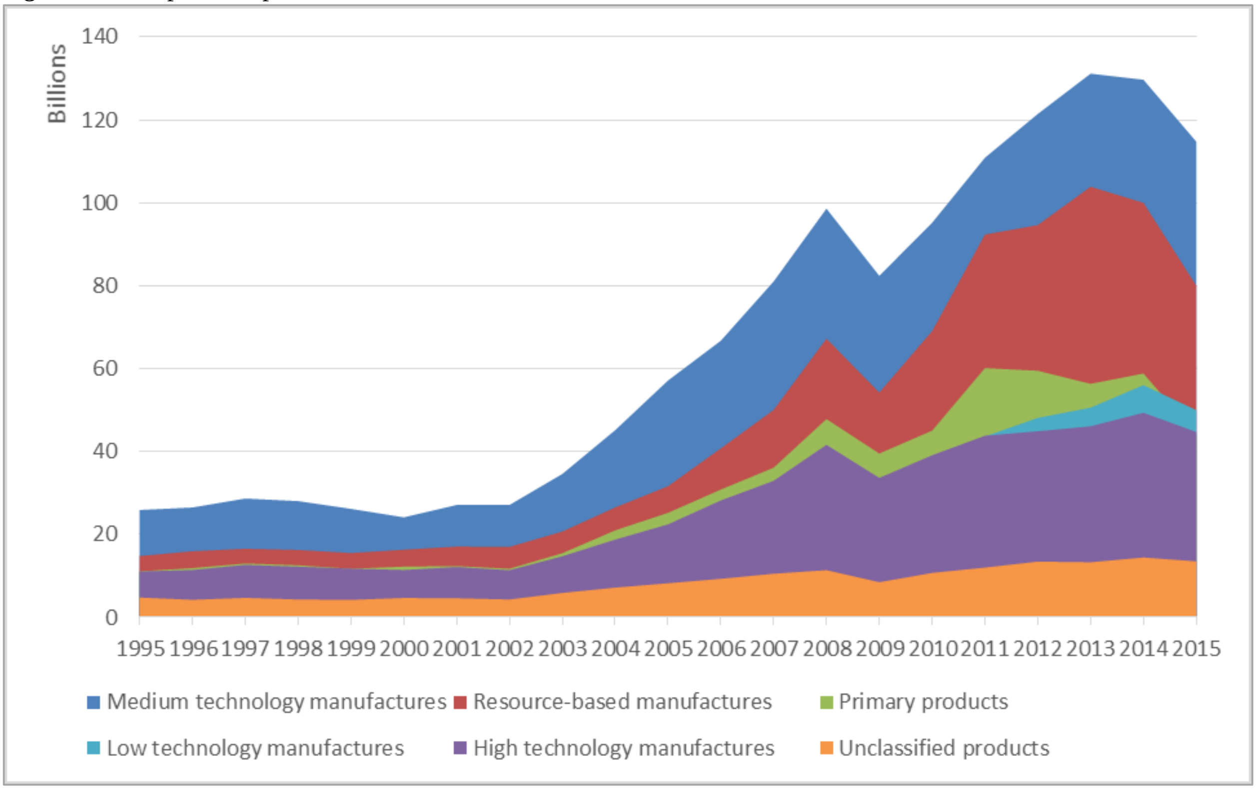
Figure 3.12b; Export composition for world regions, Lall classifications



Source: United Nations Conference on Trade and Development (2016)

Sub-Saharan Africa's import composition mainly consists of medium technology manufactures which have grown rapidly since the early 2000s. High technology manufactured products have also grown as shown in Figure 3.13.

Figure 3.13; Import composition, sub-Saharan Africa, USD



Source: United Nations Conference on Trade and Development (2016)

The high growth rates achieved in sub-Saharan Africa since the early 2000s have been the result of high commodity prices (United Nations Economic Commission for Africa, 2013). Although they fell in 2008 following the global financial crisis, they saw a quick recovery due to strong resilient growth in emerging economies, in particular China and India. However, growth in China has slowed in recent years, coupled with low growth in Europe due to the sovereign debt crisis, commodity prices have plummeted.

Figure 3.14a; Commodity prices

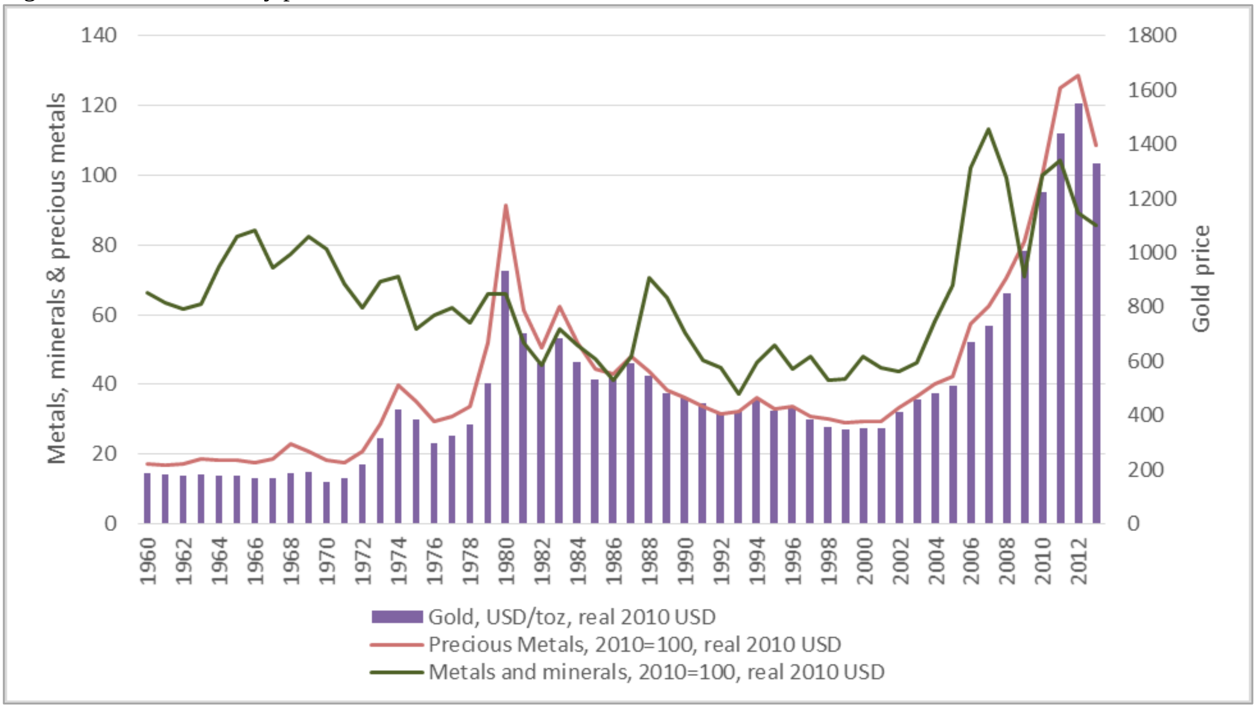
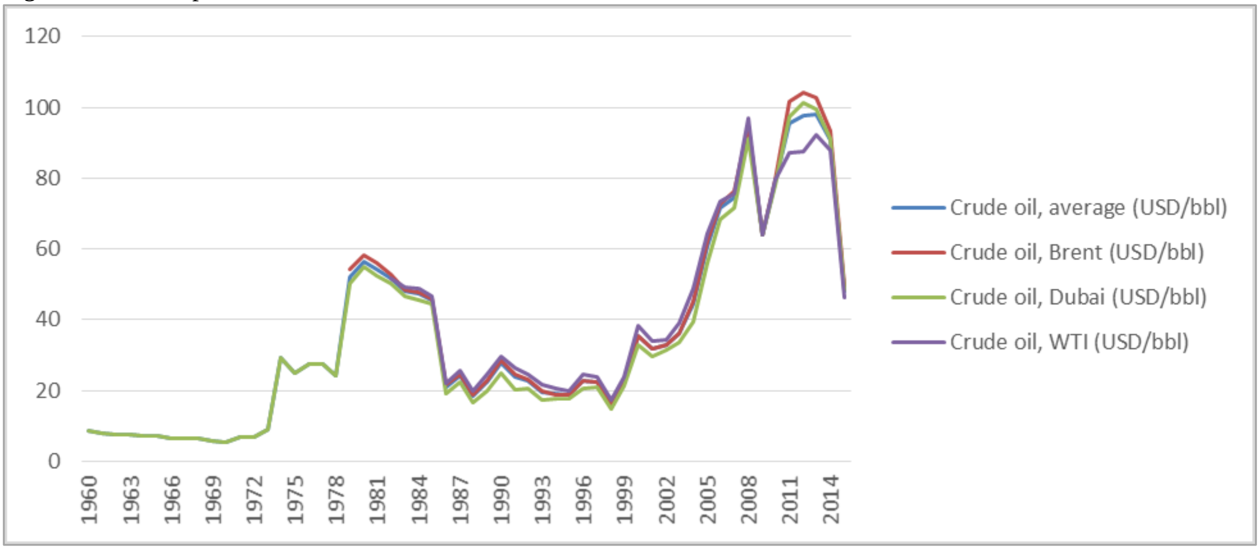


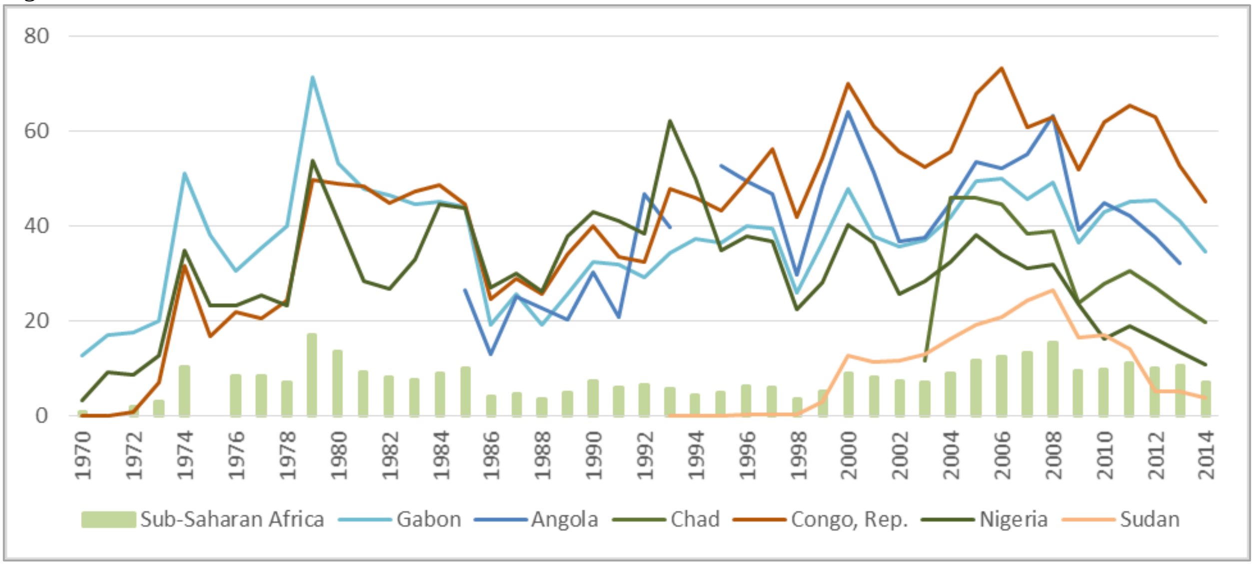
Figure 3.14b; Oil prices



Source: World Bank (2016)

Figure 3.14 shows the recent fall in oil prices. This has had a negative effect on a selection of sub-Saharan African countries who heavily depend on the export of oil. In 2008, oil rents for the region were 15.6% of GDP. Figure 3.15 shows the countries in the region with the highest portion of oil rents as a percentage of GDP.

Figure 3.15; Oil rents, % of GDP



Source: World Bank (2016)

On average, during the 1970 to 2014 period, the majority of sub-Saharan African countries experienced current account deficits. Countries experiencing on average a surplus were Botswana, Namibia, Angola, Gabon and Nigeria. The latter three are oil exporting economies which have benefited from relatively high oil prices since the early 2000s. These countries have seen a fall in their current account surplus in recent years following the fall in oil prices. The current account balance as a percentage of GDP in the largest 7 economies can be seen in Figure 3.16. With the exception of Angola and Nigeria, the largest sub-Saharan African economies experienced current account deficits.

Figure 3.16; Current account balance, % of GDP, largest economies in sub-Saharan Africa

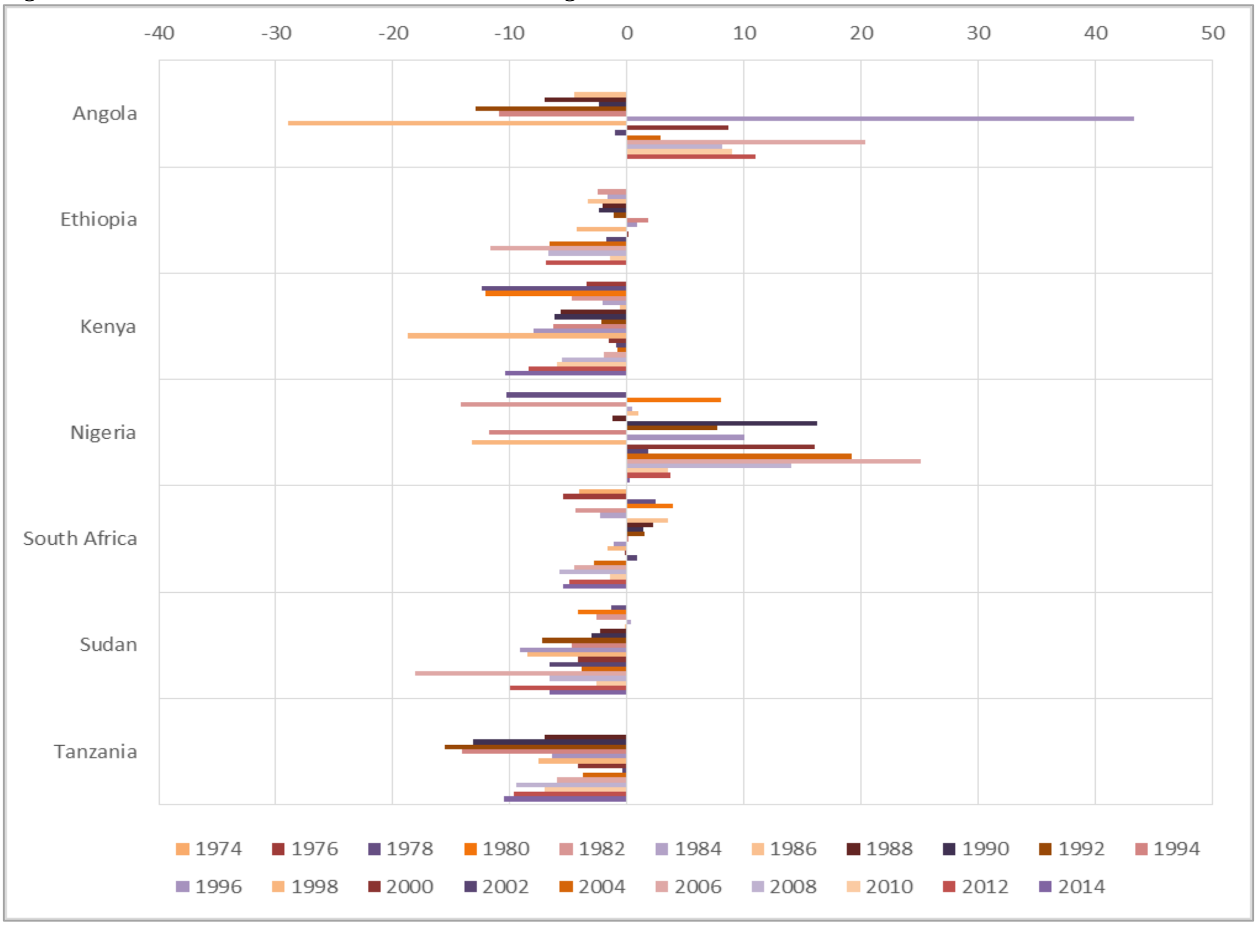
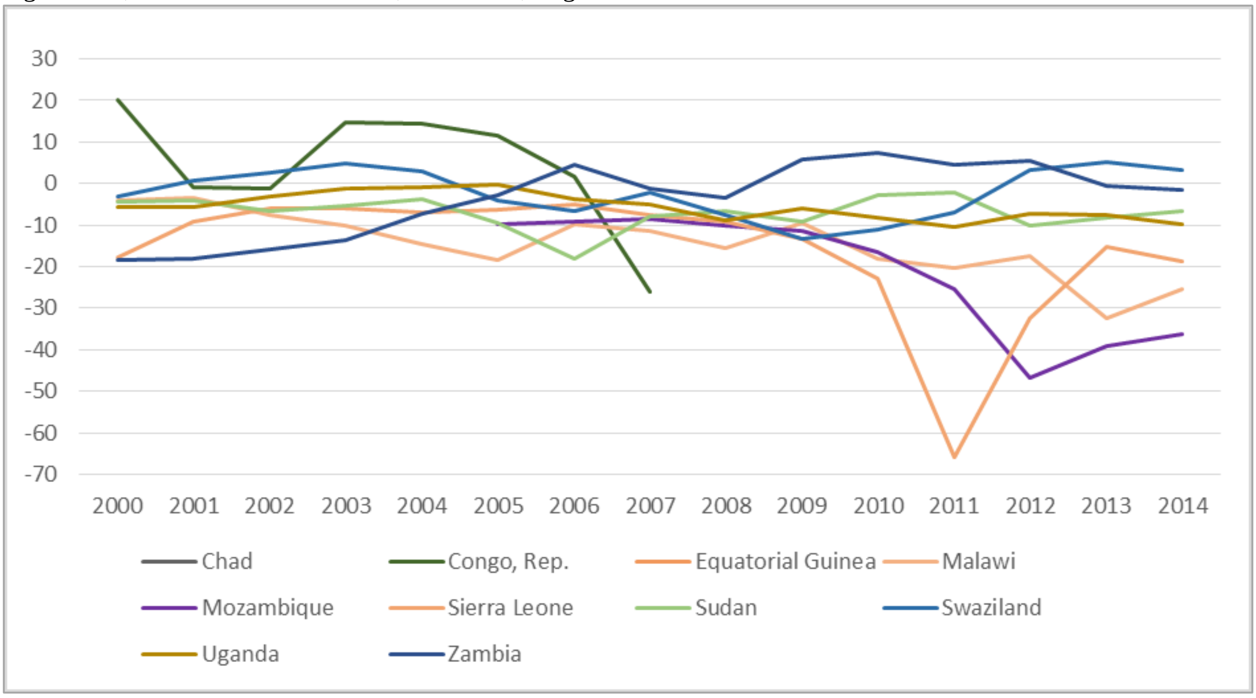


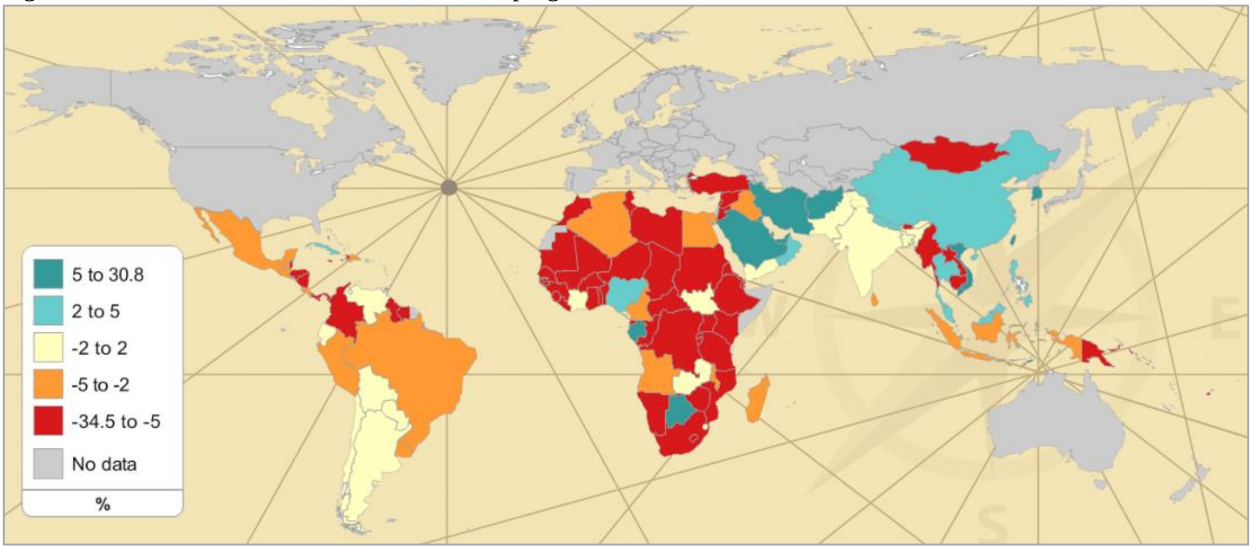
Figure 3.17; Current account balance, % of GDP, largest decline since 2000



Source: World Bank (2016)

Since the early 2000s, there has been a deterioration in the current account balance in non-oil exporting countries. The largest declines, as a percentage of GDP, were in Malawi, Mozambique and Sierra Leone as seen in Figure 3.17. Figure 3.18 shows the current account balance for developing countries in 2014. It is clear that the sub-Saharan African region faced the largest deficit, as a percentage of GDP.

Figure 3.18; Current account balance for developing countries, % of GDP, 2014



Source: United Nations Conference on Trade and Development (2016)

3.5. Concluding Remarks

Since the early 2000s, sub-Saharan Africa has experienced impressive economic growth, as one of the fastest growing world regions. However, poverty levels remain persistently high as inequality increased in some of the largest economies in the region.

Sub-Saharan African exports account for a mere 1.7% of world exports. This is down from 4.5% in 1960. This is concerning as the region has lost 62.2% of its share of trade with the rest of the world.

Following structural adjustment programs in the late 1980s, sub-Saharan Africa has increased its specialisation in the production and export of primary products. In 2008, the share of primary and resource based manufactured products peaked at 84.8%. The region is therefore left vulnerable to fluctuations in commodity prices as well as exogenous shocks. This is most evident with the recent growth slowdown in China, coupled with low growth in Europe due the ongoing sovereign debt crisis, which had left many sub-Saharan African countries such as Botswana, Burundi, Equatorial Guinea and Sierra Leone amongst others, facing economic contraction in 2015 (World Bank, 2016).

With the exception of five countries, the rest of the region on average experienced a current account deficit between the 1974 and 2014 period. In 2014, compared to other developing countries, sub-Saharan Africa had the largest current account deficit to GDP ratio. These countries therefore appear to have been balance of payments constrained.

Chapter 4

4. THE NATURAL RATE OF GROWTH

The natural rate of growth is the growth rate required to keep the unemployment rate constant. Assuming full employment, it is the maximum growth rate permitted given population growth, capital accumulation, technology improvement and the work/leisure preference schedule. Although originally defined as exogenous (Harrod, 1939), several studies have provided empirical evidence that the natural rate of growth is endogenous to the actual rate of growth for numerous middle and high income countries (Leon-Ledesma and Thirlwall, 2002; Libanio, 2009; Vogel, 2009; Dray and Thirlwall, 2011; Lanzafame, 2014). No studies to date have been carried out on low income countries or for the sub-Saharan African region. In addition, the literature distinguishes between advanced economies and developing economies (Dray and Thirlwall, 2011), however very little is known about the variability in the responsiveness of the natural rate of growth to demand changes for developing countries which are made up of a diverse range of economies.

This chapter therefore aims to address the following sub-questions, (i) What is the natural rate of growth for sub-Saharan Africa and is it endogenous to demand shocks? (ii) How does the sensitivity in the natural rate of growth to demand changes differ among developing countries? This is done by estimating the natural rate of growth for the region and testing if it is endogenous to demand shocks.

Investigating whether the natural rate of growth is endogenous or exogenous is imperative as it lies at the heart of the debate between neoclassical growth theory (which takes the natural rate of growth as exogenous to the actual rate of growth) and the post-Keynesian theory, which maintains that the labour force growth and productivity growth respond to both foreign and domestic demand. The natural rate of growth is treated as endogenous to the actual rate of growth.

We make a further contribution to understanding the sensitivity of the natural rate of growth, i.e. its responsiveness to demand during the boom periods for developing countries by distinguishing between low income, lower middle income and upper middle income economies.

In sections 4.1 to 4.3, data for 31 sub-Saharan African countries for the 1991 to 2012 period is used to estimate the natural rate of growth as well as empirically test if it is endogenous to the actual rate of growth. This sheds light on the relevance of demand for economic growth in the region. The time period is limited due to data availability. Any results obtained from time series analysis are therefore only indicative. In order to overcome this limitation, panel data analysis determining the endogeneity of the natural rate of growth is used to complement the time series results. Both the time series and panel data analysis provide support for the endogeneity of the natural rate of growth, i.e. the natural rate of growth responds to domestic and foreign demand.

Our results indicate the presence of a U shaped relationship between the natural rate of growth and the level of economic development. Low income economies proved to be most sensitive to demand changes. The reasons for this are discussed in section 4.4. The results further indicate that a demand-led growth model may be applicable in the region.

4.1. Data and Methodology

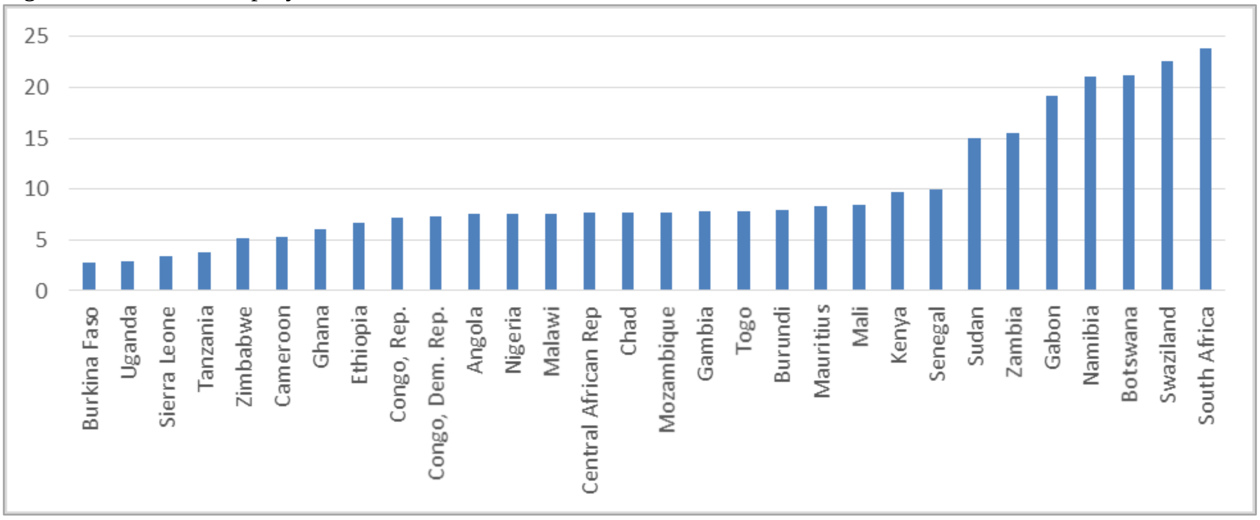
The endogeneity of the natural rate of growth for sub-Saharan Africa is tested in this section. We begin with an outline of the data used as well as some stylised facts. Section 4.1.2 outlines the two models used to estimate the natural rate of growth, i.e. the Okun (1962) specification and the Thirlwall (1969) specification. In line with the literature, both specifications are used to estimate the natural rate of growth and the results from both are compared.

4.1.1. Data and Stylised Facts

The unemployment rate and the percentage growth in GDP are used to estimate the natural rate of growth for 31 sub-Saharan countries for the 1991 to 2012 period. The mean, standard deviation, minimum and maximum values can be seen in Appendix A. The mean unemployment rate is shown in Figure 4.1 and ranged from 2.9% in Uganda to 23.9% in South Africa. It must be noted the unemployment rate does not distinguish between those employed in the formal and informal sector.

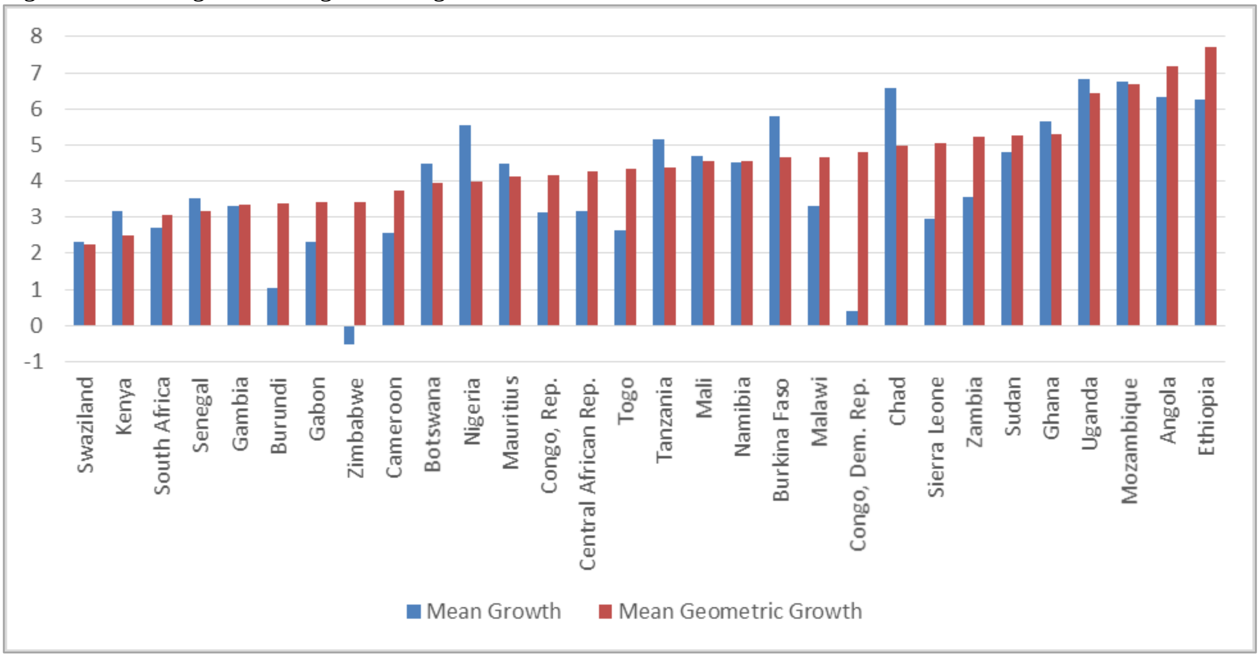
The mean growth rate for the respective countries is shown in Figure 4.2 and ranged from -0.5% for Zimbabwe to 6.7% for Namibia. The geometric mean is also given and ranged from 2.2% for Swaziland to 7.1% for Ethiopia. In recent years, African countries have been experiencing high growth rates due to a boom in commodity prices driven by high growth rates in China and India (United Nations Conference on Trade and Development, 2013).

Figure 4.1; Mean unemployment rate, 1991 to 2012



Source: World Bank (2014)

Figure 4.2; Mean growth and geometric growth, 1991 to 2012



Source: World Bank (2014)

4.1.2. The Empirical Model

Two different approaches will be used to estimate the natural rate of growth for each of the 31 sub-Saharan African countries using both time series and panel data analysis for the 1991 to 2012 period. The first approach derives from the specification proposed by Okun (1962) between unemployment and growth, which enables us to write the empirical model as follows:

$$\Delta\%U_t = a + b(g)_t + \varepsilon_t \qquad \text{(For time series estimations)} \qquad \text{(Equation 4.1a)}$$

And

$$\Delta\%U_{it} = a + b(g)_{it} + \varepsilon_{it} \qquad \text{(For panel data estimations)} \qquad \text{(Equation 4.1b)}$$

here, $\Delta\%U$ is the change in the percentage level of unemployment and g is the actual growth of output. The coefficient b measures the reduction in unemployment when growth increases by one unit and it is expected to be negative ($b<0$). Once estimated, model 4.1 can be used to obtain the natural growth rate (y^*), which is observed when the change in unemployment is zero, i.e. when, $\Delta\%U = 0$. Under this specification, $y^* = -(a/b)$.

The estimates of a and b may be biased downward due to dropouts in the labour force and labour hoarding during recessions. In order to overcome this bias, the natural rate of growth can be directly estimated using a modified approach as suggested by Thirlwall (1969):

$$g_t = a_1 + b_1(\Delta\%U)_t + \nu_t \qquad \text{(For time series estimations)} \qquad \text{(Equation 4.2a)}$$

And

$$g_{it} = a_1 + b_1(\Delta\%U)_{it} + \nu_{it} \qquad \text{(For panel data estimations)} \qquad \text{(Equation 4.2b)}$$

where the constant term a_1, is the natural rate of growth. As $\Delta\%U$, is not exogenous, the coefficient estimates of Equation 4.2 will be statistically biased although it is difficult to know a priori to what extent. The Thirlwall (1969) specification could be preferred to the Okun (1962) specification due to its simplicity in interpretation as no additional calculations are needed to determine the natural rate of growth.

Equations 4.1 and 4.2 will be estimated by Ordinary Least Squares (OLS). The results from both equations are compared by looking at the significance of the individual estimates and the overall significance of the model. The signs of the estimates will be checked to see if they are consistent with theoretical expectations about the natural rate of growth. We do not expect any major differences between the two specifications however in line with the literature, both equations are estimated.

Two Stage Least Squares (TSLS) using an instrumental variables approach in order to address the endogeneity of unemployment will also be applied to Equation 4.2. Due to the difficulty in finding good instruments, we use the lagged values of the variables as instruments which is in line with the literature as a study by Leon-Ledesma and Thirlwall (2002) used the lagged values of both unemployment and growth as instruments. The Sargan score Lagrange Multiplier (LM) test is used to check the validity of the instruments, while the F test is used to determine the strength of the instruments.

Different specifications will therefore be applied to estimate Equation 4.2. The first uses simple OLS, second is the TSLS instrumental variable approach estimated firstly using the lagged values of both unemployment and growth and then using only the lagged values of unemployment as instruments. We also apply a panel instrumental variable approach to the latter.

Next, based on the estimation results of Equation 4.2, deviations of the actual rate of growth from the estimated natural rate of growth can be calculated and a revised equation can be estimated by introducing a dummy variable, where D=1 for periods when the actual rate of growth is above the natural rate of growth and zero otherwise. The specification is as follows:

$$g_t = a_2 + b_2(D)_t + c_2(\Delta\%U)_t \quad \text{(For time series estimations)} \quad \text{(Equation 4.3a)}$$

And

$$g_{it} = a_2 + b_2(D)_{it} + c_2(\Delta\%U)_{it} \quad \text{(For panel data estimations)} \quad \text{(Equation 4.3b)}$$

if the coefficient a_2 plus b_2 is significantly higher than the original constant a_1 in Equation 4.2, then during the boom period, the actual rate of growth must have increased the natural rate of growth to keep the unemployment rate constant.

Leon-Ledesma and Thirlwall (2002) identify the mechanisms through which the natural rate of growth may be endogenous to the actual rate of growth. Firstly, growth in labour inputs increases when output growth is buoyant as hours worked increases, participation rates increase, there is reallocation of labour from low to high productivity sectors and migration may also occur. Secondly, labour productivity may be enhanced as output growth increases as apparent in the Verdoorn-Kaldor (1966) relation.

4.1.3. Estimations

Both time series and panel data techniques are used to estimate the natural rate of growth specified in Equations 4.1 to 4.3. This is due to the limited time series of the data as annual data covering the 1991 to 2012 period is available. Unit root tests are used to pre-test the data for stationarity. The results indicate that growth in income and the change in the unemployment rate are stationary for all countries included in the analysis with the exception of Swaziland. The results are given in Appendix B. We therefore proceed with the time series estimations for the natural rate of growth using OLS. If autocorrelation is found to be present, then the method of Generalised Least Squares (GLS) is applied. If heteroscedasticity is found in the error terms, then Newey-West Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors will be used.

As can be seen in section 4.1, there are large differences in the growth experience of the sub-Saharan African countries. Grouping these countries into one panel data set would be less informative as the results would give an overall average for the region. We therefore make use of

Seemingly Unrelated Regressions (SUR) analysis to determine which countries share the same parameters and therefore can be grouped together. 11 different pools are created and the natural rate of growth is estimated for specification 4.1 to 4.3 using either the fixed effects or random effects estimator, based on the Hausman test. The error terms are tested for heteroscedasticity and where present, heteroscedasticity consistent standard errors are applied.

4.1.3.1. Time Series Estimation

The natural rate of growth and its endogeneity is estimated separately for each country using Equations 4.1 to 4.3, with time series data for the 1991 to 2012 period. As the study uses time series data, autocorrelation is most likely to be present. Two tests will be used to test for autocorrelation, the Durbin-Watson d test and the Breusch-Godfrey (BG) alternatively known as the Lagrange Multiplier (LM) test. If autocorrelation is present the OLS estimators are still unbiased and consistent however they are no longer efficient. This is because in most cases the OLS standard errors will be underestimated leading to inflated t values which would indicate that a coefficient is more significant than it actually may be.

If autocorrelation is found to be present, then the method of GLS is applied. This method is preferred to the Newey-West HAC standard errors as the sample size is small. The GLS Cochrane-Orcutt iterative procedure is the method used in the literature (Leone-Ledesma and Thirlwall, 2002; Dray and Thirlwall, 2011). One drawback with the procedure is that it uses the first difference and therefore loses the first observation. According to Gujarati (2008), the loss may make a substantial difference to the obtained results. Both the Newey-West standard errors and Cochrane-Orcutt iterative procedure will be applied where autocorrelation is detected and if the two differ by more than 1%, then the Prais-Winsten transformation will be applied to see if the difference between the two results is due to the lost observation. If this is the case, then the Prais-Winsten transformation will be used.

The model will also be checked for heteroscedasticity, using the Breusch-Pagan (BP) test for heteroscedasticity. If heteroscedasticity and autocorrelation are found to be present in the model then the Newey-West HAC standard errors are applied. The Newey-West method estimates a kernel which is the weighted average of the number of errors. The number of errors to include is known as the bandwidth. There is a trade-off between the two as a larger bandwidth will reduce bias while increasing variance. The method used to choose the optimal bandwidth is based on the sample size;

B=0.75N1/3

where, B is bandwidth and, N is the sample size, hence the larger the sample size the larger the bandwidth (Adkins and Hill, 2008)[26].

As some countries in the sub-Saharan African region have been plagued with political unrest and economic instability, dummy variables will be added where structural breaks are suspected. Only significant dummy variables will be retained in the model.

4.1.3.2. Panel Data Estimation

Panel data estimation techniques are applied as the data is annual, covering the 1991 to 2012 period therefore making any results obtained from time series estimations only indicative due to the limited degrees of freedom. Countries with similar parameters using SUR are therefore pooled together and the natural rate of growth in Equations 4.1 to 4.3 estimated using the fixed or random panel data estimation techniques. Equations 4.1 to 4.3 are also estimated using a pool with all countries in order to determine the average value of the natural rate of growth as well as test the average increase across the region during the boom. An Instrumental Variable (IV) approach is used with the entire pool of countries as the technique relies on a large sample size, in order to address the bias resulting from the endogeneity of the unemployment rate.

4.1.3.3. Pooling Countries

Due to the large variability in the growth performance in the sub-Saharan African countries, the research makes use of a generalised least squares estimation procedure. SUR estimations are used to determine which countries can be pooled together. We first jointly estimate the individual equations accounting for the different variance in the error terms and the contemporaneous correlation between the errors in the equations for individual countries (Hill et al, 2008). Using the specification in Equation 4.2 proposed by Thirlwall (1969), different country combinations are estimated and the equality of the coefficients are tested. Only if the natural rate of growth and the coefficient on the change in the unemployment rate are not statistically different across the grouped countries according to the Wald test, are countries pooled.

Table 4.1a shows the country subgroups generated from the pooling exercise. Appendix C reports the results from the Wald test used to test for the equality of the constant and the coefficient on the percentage change in the unemployment rate. In total there are 11 groups. The advantage of creating different subgroups instead of one single panel data set for all countries is that we are able to observe the variability in the natural rate of growth.

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[26] As the average sample size used in this chapter is 21, the estimated bandwidth is 2.5 which is rounded to 3.

Table 4.1a; Pooled countries

	Countries[27]
Group 1	South Africa and Swaziland
Group 2	Zimbabwe, Zambia, Namibia and Botswana
Group 3	Angola, Mozambique and Democratic Republic of Congo
Group 4	Uganda and Ethiopia
Group 5	Chad and Central African Republic
Group 6	Cameroon and Gabon
Group 7	Nigeria and Togo
Group 8	Ghana and Burkina Faso
Group 9	Sierra Leone, Gambia and Senegal
Group 10	Malawi, Kenya and Republic of Congo
Group 11	Tanzania, Ghana and Mali

Most of the countries pooled are in close geographical proximity which makes it likely that they would experience similar shocks. For instance Swaziland is completely surrounded by South Africa, one of the largest economies in sub-Saharan Africa, while Zimbabwe, Zambia, Namibia and Botswana are all part of the Southern African Development Countries (SADC) block with each sharing a common neighbour. Only for group 10 and 11 did the countries grouped together not share a common neighbour. Some countries grouped also appear to experience the same colonial legacy, for instance Angola and Mozambique, both former Portuguese colonies with strong economic ties.

4.1.3.3.1. Grouping Countries Based on Income Levels

In addition to the pooling exercise outlined above, countries will be separated based on their level of development. We distinguish between low income economies, lower middle income economies, upper middle income economies and high income economies based on their Gross National Income (GNI) per capita as shown in Table 4.1b.

[27] Equatorial Guinea is excluded from the grouping as it experienced abnormal growth rates.

Table 4.1b; Country groups based on income levels

Category	Description[28]	Countries
Low income	Countries which have a GNI per capita of USD1,045 or less	Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of Congo, Ethiopia, Gambia, Kenya, Malawi, Mali, Mozambique, Sierra Leone, Tanzania, Togo, Uganda and Zimbabwe
Lower middle income	Countries which have a GNI per capita between USD1,046 and USD4,125	Cameroon, Republic of Congo, Ghana, Nigeria, Senegal, Sudan, Swaziland and Zambia
Upper middle income	Countries which have a GNI per capita between USD4,126 and USD12,745	Angola, Botswana, Gabon, Mauritius, Namibia and South Africa
High income	Countries which have a GNI per capita of USD12,746 or more	Equatorial Guinea

4.1.3.3.2. Estimating the Natural Rate of Growth using Panel Data

In order to estimate the natural rate of growth, two different estimation techniques are used. The first is the fixed effects estimator. As it measures deviations from individual means, the coefficient estimates depend on the variation of the explanatory and dependent variables within countries (Hill et al, 2008). Variations arising between different countries therefore do not influence the coefficient. With this technique we assume that all the individual differences are captured by differences in the intercept parameter.

The other estimation technique used is the random effects model where individual differences between countries are captured by the intercept however the individual differences are treated as random as opposed to fixed. The random effects are analogous to random error terms and therefore follow the same assumptions in the error term as OLS of zero mean, uncorrelated across countries and the presence of constant variance.

The Hausman test is used to determine if the fixed effects or random effects model should be used to estimate the natural rate of growth. Heteroscedasticity is tested using the BP test for independence. In the presence of heteroscedasticity, we apply heteroscedasticity consistent standard errors. Time effects are included in the model and retained only when significant.

As we hypothesise that the natural rate of growth is endogenous to the actual rate of growth, an IV approach is also applied using the lags of the variables as instruments[29]. This approach is only estimated using the entire pool of countries as the method relies on a large sample size. However

[28] World Bank (2013) definitions used.
[29] 2 lags are used as determined by the F statistic from the first stage regression.

caution is still needed as Wooldridge (2007) shows that the estimates obtained from IV will not be efficient if the instruments are weak, even in the presence of a large sample size. Furthermore in our case where the time series dimension is rather short, even with the pooled data set, the IV results can be at best indicative.

4.1.4. Correlation Analysis with Development and Institutional Indicators

We test the correlation between the increase in the natural rate of growth during the boom period and key indicators related to economic development, governance and institutions using both Pearson’s correlation coefficient and Spearman’s rank correlation coefficient. The latter is applied as it is less sensitive to extreme values than the former. The results are discussed in section 4.4.

4.2. Time Series Estimation Results

The results from Okun (1962) specification as defined in Equation 4.1 can be seen in Table 4.2. The results are from the time series analysis for the 1991 to 2012 period. Although these results are only indicative due to the limited degrees of freedom, they are nevertheless informative on the country specific natural rate of growth and they will serve as a benchmark for comparison with the panel data estimations. The natural rate of growth could be estimated for 26 out of 31 countries and it ranged from 0.2 for Botswana to 19.8 for Uganda. For 12 out of the 26 countries, the natural rate of growth was significant at the 95% confidence level using the Wald test for the significance of a/b. The natural rate of growth was not significant for Botswana, Burkina Faso, the Democratic Republic of Congo, Ethiopia, Gabon, Ghana, Mali, Nigeria, South Africa, Tanzania, Togo, Uganda and Zimbabwe. The natural rate of growth using this specification could not be estimated for Cameroon, Kenya, Namibia, Sierra Leone, Sudan, Swaziland and Zambia as the constant had the wrong sign, i.e. the constant is negative when it is theoretically expected to be positive (Okun, 1962).

Table 4.2; Results from Okun's specification based on Equation 4.1

Country	Constant	Growth in GDP	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth[N]
Angola	0.055	-0.009**	0.226	5.55**	1.741	0.315	0.04	6.1**
	(0.045)	(0.004)						
Botswana[30]	0.008	-0.041	0.150	1.58	1.881	0.003	0.50	0.195
	(0.832)	(0.147)						
Burkina Faso[co]	0.277*	-0.041	0.120	2.46	2.12[trans]			6.756
	(0.157)	(0.026)						
Burundi	0.007	-0.008**	0.253	6.45**	1.477	0.848	0.17	0.875**
	(0.014)	(0.003)						
Cameroon[co]	-0.244	0.052	0.018	0.33	2.101[trans]			
	(0.339)	(0.090)						
Central African Rep.	0.037	-0.013***	0.306	8.38***	2.665	2.512	0.29	2.846***
	(0.024)	(0.004)						
Chad[nw]	0.063***	-0.008		6.82**				7.875***
	(0.018)	(0.003)						
Congo, Dem. Rep.[31]	0.038	-0.008	0.103	1.03	2.159	0.237	0.01	4.75
	(0.039)	(0.005)						
Congo, Rep.	0.046**	-0.0176***	0.487	18.03***	1.834	0.140	1.86	2.614***
	(0.020)	(0.004)						
Equatorial Guinea	0.161	-0.009**	0.194	4.56**	1.714	0.054	0.01	17.8**
	(0.108)	(0.004)						
Ethiopia[co]	0.070	-0.0199	0.101	2.01	1.840 [trans]			3.518
	(0.198)	(0.014)						
Gabon[co]	0.205	-0.021	0.049	0.93	1.354 [trans]			9.762
	(0.161)	(0.021)						
Gambia	0.049*	-0.0176***	0.345	9.99***	2.099	0.868	1.67	2.784**
	(0.026)	(0.006)						
Ghana[co]	0.023	-0.0197	0.001	0.01	2.002 [trans]			1.1675
	(1.043)	(0.169)						
Kenya[co]	-0.046***	-0.000	0.000	0.00	2.303 [trans]			
	(0.015)	(0.004)						
Malawi[32]	0.135***	-0.032***	0.765	29.31***	1.844	0.107	0.90	4.219***
	(0.030)	(0.004)						
Mali	0.026	-0.008	0.017	0.34	2.299	0.735	0.94	3.25
	(0.084)	(0.014)						
Mauritius	0.692**	-0.171**	0.243	6.12**	1.459	1.426	0.04	4.046**
	(0.331)	(0.069)						
Mozambique[nw]	0.159***	-0.026***		41.33***				6.115***
	(0.020)	(0.004)						
Namibia[co33]	-2.039	0.128	0.894	71.71***	2.178 [trans]			
	(1.474)	(0.128)						
Nigeria[34]	0.032	-0.007*	0.259	3.16*	2.245	1.136	0.34	4.571
	(0.022)	(0.004)						

Table continues …

[30] Dummy added for 2009 where there was negative growth of -7.8% due to the financial crisis.
[31] Dummy added for 1991 to 2001.
[32] Dummy added for 2010 negative growth of -9%.
[33] Dummy added for 2008 where the unemployment rate was abnormally high at 37.6%.
[34] Dummy added for 2004 where there was high growth of 33.7%.

Country	Constant	Growth in GDP	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth[N]
Senegal	0.088*** (0.028)	-0.0246*** (0.007)	0.397	12.49***	1.584	0.805	0.47	3.577***
Sierra Leone	-0.003 (0.013)	0.001 (0.001)	0.041	0.81	1.946	0.008	0.22	
South Africa	0.528 (0.816)	-0.170 (0.232)	0.027	0.54	1.913	0.023		3.106
Sudan[nw]	-0.068 (0.552)	0.008 (0.011)		0.60				
Swaziland[nw]	-0.036 (0.087)	0.013 (0.039)		0.12				
Swaziland[D]	-0.003 (0.038)	-0.103** (0.038)	0.249	4.32**	1.362	0.112	0.243	
Tanzania[nw]	0.365* (0.210)	-0.069 (0.052)		1.81				5.289
Togo[35]	0.0258 (0.023)	-0.007* (0.003)	0.633	15.51***	1.908	0.034	0.46	3.685
Uganda[co36]	0.0495 (0.246)	-0.0025 (0.028)	0.436	6.59***	1.453 [trans]			19.8
Zambia	-0.388 (0.359)	0.030 (0.065)	0.011	0.21	1.680	0.488	0.91	
Zimbabwe[37]	0.0335 (0.133)	-0.0037 (0.018)	0.110	1.12	1.826	0.170	0.17	9.054

Note: The natural rate of growth is estimated as a/b and the Wald test is used to test its significance. Results from the Wald test are available upon request
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
[co] Cochrane-Orcutt iterative procedure used to correct for autocorrelation
[pw]Prais-Winsten transformation used to correct for autocorrelation when Cochrane-Orcutt iterative procedure is not appropriate
[nw] Newey-West heteroscedasticity and autocorrelation consistent (HAC) standard errors used to correct for autocorrelation and heteroscedasticity
[trans] is the transformed Durbin-Watson statistic from the Cochrane-Orcutt iterative procedure
[D] refers to the first difference specification used for Swaziland. As the unit root tests indicated that GDP growth is I(1), we take the first difference of GDP growth and re estimate using OLS

The estimation results for the natural rate of growth using Thirlwall (1969) specification in Equation 4.2 can be seen in Table 4.3. The natural rate of growth was statistically significant at the 95% level for all countries with the exception of Zimbabwe where it was significant at the 90% level and Burundi where it was not significant.

[35] Dummy added for 1994 where there was an abnormally low unemployment rate.
[36] Dummy added for 2009 where there was a large change in the unemployment rate.
[37] Dummy added for 2002 to 2008 period due to the economic crash.

Table 4.3; Results from Thirlwall's specification based on Equation 4.2

Country	Constant	%ΔU	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth[N]
Angola[co38]	7.887*** (2.425)	-9.355 (8.816)	0.588	12.16***	1.061[trans]			7.887***
Botswana[39]	4.947*** (0.641)	-0.104 (0.376)	0.518	9.68***	2.164	0.274	0.53	4.947***
Burkina Faso	5.674*** (0.607)	-1.496 (1.479)	0.051	1.02	1.729	0.020	1.09	5.674***
Burundi[co]	0.772 (1.609)	-23.296 (11.517)*	0.185	4.09*	1.762[trans]			0.772
Cameroon[co 40]	3.948*** (1.008)	-0.249 (0.262)	0.079	0.73	1.925[trans]			3.948***
Central African Rep.	3.222*** (0.841)	-24.341*** (8.411)	0.306	8.38***	1.446	0.778	0.08	3.222***
Chad	6.861*** (1.902)	-25.416** (11.974)	0.192	4.51**	1.332	2.730*	1.44	6.861***
Congo, Dem. Rep.[nw]	5.856*** (0.411)	-12.182** (5.517)		26.1***				5.856***
Congo, Rep.[co]	2.972*** (1.031)	-27.778*** (4.905)	0.641	32.07***	1.766[trans]			2.972***
Equatorial Guinea[41]	16.084*** (3.683)	-13.561 (9.898	0.416	6.41***	1.172	3.548*	0.04	16.08***
Ethiopia	6.735*** (1.391)	-1.701 (3.632)	0.011	0.22	1.489	0.206	0.18	6.735***
Gabon[42]	2.677*** (0.680)	0.917 (1.131)	0.447	7.26***	1.731	0.074	0.73	2.677***
Gambia	3.143*** (0.605)	-19.592*** (6.199)	0.345	9.99***	1.898	0.025	2.48	3.143***
Ghana[43]	5.216*** (0.349)	0.051 (0.137)	0.678	18.96***	1.352	1.702	0.53	5.216***
Kenya[co]	3.389*** (0.791)	-3.830 (6.727)	0.018	0.32	2.073[trans]			3.389***
Malawi[co44]	4.236*** (1.058)	-22.264*** (2.424)	0.873	58.50***	1.754[trans]			4.236***
Mali	4.812*** (0.718)	-2.075 (3.567)	0.017	0.34	2.022	0.328	0.28	4.812***
Mauritius	4.368*** (0.349)	-1.426** (0.575)	0.243	6.12**	2.372	1.260	0.96	4.368***
Mozambique[45]	7.115*** (0.515)	-8.861** (3.891)	0.664	17.77***	1.994	0.000	0.01	7.115***

Table continues …

[38] Dummy added for the 1991 to 1993 period where there was negative growth due to the civil war.
[39] Dummy added for 2009 where there was negative growth of -7.8% due to the financial crisis.
[40] Dummy added for 1996 where there was a large increase in the unemployment rate.
[41] Dummy added for 1997 high growth of 71.8%.
[42] Dummy added for 1999 negative growth of -8.9%.
[43] Dummy added for 2011 high growth of 15%.
[44] Dummy added for 2010 negative growth of -9%.
[45] Dummy added for 1992 negative growth of -5%.

Country	Constant	%ΔU	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth[N]
Namibia	4.616*** (0.647)	-0.062 (0.139)	0.177	1.94	2.622	2.341	0.4	4.616***
Nigeria[co][46]	4.818*** (0.877)	-14.606 (9.518)	0.890	68.75***	2.214[trans]			4.818***
Senegal[co][47]	3.629*** (0.637)	-17.878*** (3.369)	0.610	28.16***	1.652[trans]			3.629***
Sierra Leone	4.099** (1.729)	41.229 (38.673)	0.349	4.82**	1.747	0.123	0.43	4.099**
South Africa[co][48]	3.571*** (0.429)	-0.026 (0.114)	0.575	11.51***	1.734[trans]			3.571***
Sudan[49]	5.607*** (0.742)	6.205 (3.965)	0.569	11.92***	1.479	2.263	0.58	5.607***
Swaziland[co][50]	2.197*** (0.664)	-1.249 (0.982)	0.331	4.21**	1.971[trans]			2.197***
Swaziland[D]	-0.059 (0.196)	-2.765** (1.026)	0.378	5.48***	2.134	0.564	0.15	
Tanzania[pw]	4.729*** (1.185)	-0.8 (0.173)			1.754[trans]			4.729***
Togo[co][51]	3.837** (1.475)	-14.612** (6.503)	0.647	15.58***	1.907[trans]			3.837***
Uganda[52]	6.864*** (0.538)	-0.059 (1.688)	0.001	0.01	1.663	0.072	0.81	6.864***
Zambia	3.817*** (0.954)	0.367 (0.796)	0.011	0.21	1.475	0.871	2.30	3.817***
Zimbabwe[53]	3.264* (1.584)	-0.649 (3.108)	0.521	9.81***	1.568	0.224	0.02	3.264*

Note: the constant is measured as the natural rate of growth
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
[co] Cochrane-Orcutt iterative procedure used to correct for autocorrelation
[nw] Newey-West heteroscedasticity and autocorrelation consistent (HAC) standard errors used to correct for autocorrelation and heteroscedasticity.
[trans] is the transformed Durbin-Watson statistic from the Cochrane-Orcutt iterative procedure and Prais-Winsten transformation
[D] refers to the first difference specification used for Swaziland. As the unit root tests indicated that GDP growth is I(1), we take the first difference of GDP growth and re estimate using OLS

[46] Dummy added for 2004 high growth of 33.7%.
[47] Dummy added for 1992 negative growth of -19%.
[48] Dummy added for 2009 negative growth of -1.5% due to the financial crisis.
[49] Dummy added for 2012 negative growth of -10%.
[50] Dummy added for 2012 negative growth of -1.5%.
[51] Dummy added for 1993 negative growth of -15%.
[52] Dummy added for 2009 where there was a large change in the unemployment rate.
[53] Dummy added for 2002 to 2008 period due to the economic crash.

For four countries, the coefficient for the percentage change in the level of unemployment was positive however the coefficient was less than 1 and insignificant at the 90% level. The natural rate of growth ranges from 0.8 for Burundi to 16.0 for Equatorial Guinea.

A comparison of the results obtained from the Okun (1962) and Thirlwall (1969) specification is shown in Table 4.4. The natural rate of growth could be estimated for all 31 countries using Thirlwall specification while it could only be estimated for 26 countries using Okun (1962) specification. The natural rate of growth using Thirlwall specification was also statistically significant for 29 countries at the 95% level or above. For Okun (1962) specification, the natural rate of growth was significant for 12 countries. As in the literature, we find that the Thirlwall (1969) specification provides more robust results. We therefore proceed with the Thirlwall (1969) specification.

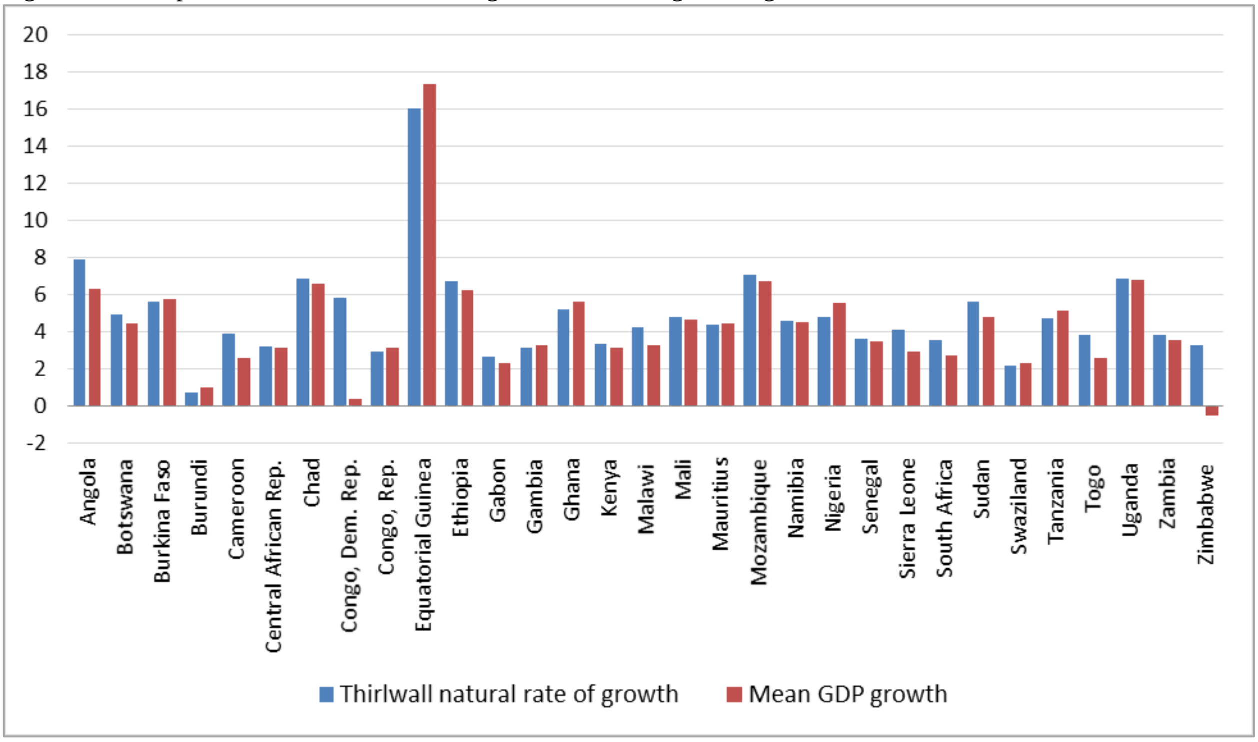
Table 4.4; Comparison of the natural rate of growth based on Okun's and Thirlwall's specification

Country	Okun specification	Thirlwall specification	Country	Okun specification	Thirlwall specification
Angola	6.1**	7.887***	Mali	3.25	4.812***
Botswana	0.195	4.947***	Mauritius	4.046**	4.368***
Burkina Faso	6.756	5.674***	Mozambique	6.115***	7.115***
Burundi	0.875**	0.772	Namibia	-	4.616***
Cameroon	-	3.948***	Nigeria	4.571	4.818***
Central African Rep.	2.846***	3.222***	Senegal	3.577***	3.629***
Chad	7.875***	6.861***	Sierra Leone	-	4.099***
Congo, Dem. Rep.	4.75	5.856***	South Africa	3.106	3.571***
Congo, Rep.	2.614***	2.972***	Sudan	-	5.607***
Equatorial Guinea	17.8**	16.084***	Swaziland	-	2.197***
Ethiopia	3.518	6.735***	Swaziland[D]	-	-
Gabon	9.762	2.677***	Tanzania	5.289	4.729***
Gambia	2.784**	3.143***	Togo	3.685	3.837***
Ghana	1.167	5.216***	Uganda	19.8	6.864***
Kenya	-	3.389***	Zambia	-	3.817***
Malawi	4.219***	4.236***	Zimbabwe	9.054	3.264*

Note: The natural rate of growth could be estimated for more countries using the Thirlwall (1969) specification
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
[D] refers to the first difference specification used for Swaziland. As the unit root tests indicated that GDP growth is I(1), we take the first difference of GDP growth and re estimate using OLS.

The estimated natural rate of growth for each respective country appears to be in line with the average GDP growth rate during the 1991 to 2012 period as shown in Figure 4.3. There is an absolute difference of 1 percentage point or less between the estimated natural rate of growth and the average actual rate of growth for all countries besides Angola where the difference is 1.5, the Democratic Republic of Congo with a difference of 5.5 and Zimbabwe with 3.7.

Figure 4.3; Comparison of the natural rate of growth and average GDP growth

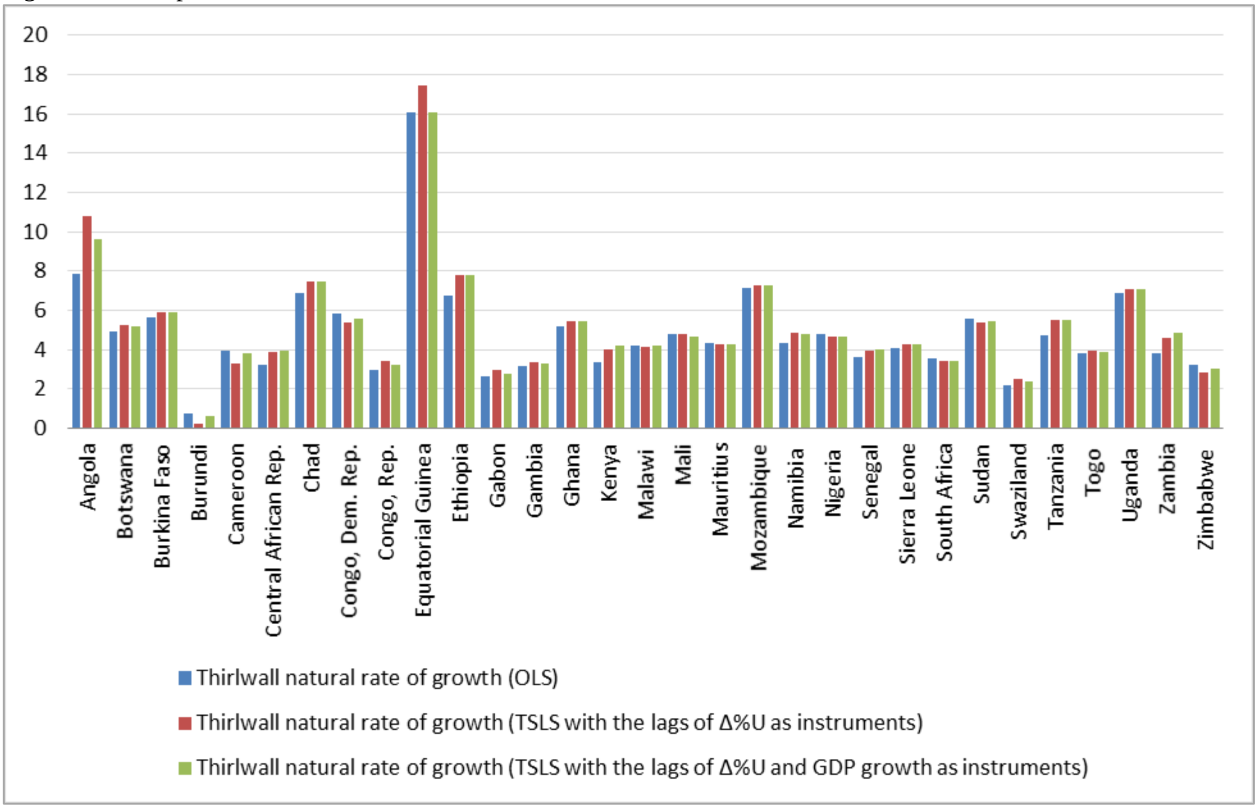


In order to address the bias resulting from the endogeneity of the unemployment rate, the robustness of the results are tested using TSLS. The results for TSLS estimations using Thirlwall's specification can be seen in Appendix E. Two different specifications are used, the first using just the lags of Δ%U and the second using both the lags of Δ%U and the lags of GDP growth. The instruments used were strong for only two countries according to the F statistic. The instruments used for the rest of the 29 countries were weak, however they were valid according to the Sargan test in 29 out of 31 countries. For Botswana, Burundi and Tanzania the instruments were weak and invalid.

In addition, we carry out the Durban and Wu-Hausman endogeneity tests. The results provide some evidence that the variables are endogenous. This was the case for Angola, Cameroon, Central African Republic, Chad, Democratic Republic of Congo, Republic of Congo, Equatorial Guinea, Gambia, Malawi, Mozambique, Senegal, South Africa, Swaziland, Togo and Zimbabwe. These countries account for roughly half of the sample. Given the short time series of the data, the endogeneity results are encouraging and provide further support for the endogeneity of the unemployment rate.

The relative difference between the natural rate of growth estimated using TSLS and OLS was less than 10% (in proportional terms) for 24 countries and less than 20% for another 6 countries. The only country where the relative difference was more than 20% was for Zambia where it was 27%. Like Leon Ledesma and Thirlwall (2002), we conclude that the bias that could arise from the endogeneity of Δ%U is unimportant. We therefore continue the analysis with the results obtained from OLS. Wooldridge (2007) shows that OLS provides better estimates than TSLS when the instruments are weak, even in large samples.

Figure 4.4; Comparison OLS and TSLS



4.2.1. Testing the Endogeneity of the Natural Rate of Growth

The endogeneity of the natural rate of growth was tested by adding a dummy variable for periods when the natural rate of growth was above the actual rate of growth as illustrated in Equation 4.3. The estimation results are reported in Table 4.5.

Table 4.5; Results for the endogeneity of natural rate of growth based on Equation 4.3

Country	Constant	Dummy	%ΔU	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth in boom periods[N]
Angola[co]	4.589***	9.11***	-0.729	0.853	30.97***	1.534[trans]			13.699***
	(1.347)	(1.754)	-5.338						
Botswana	2.845***	4.774***	0.132	0.880	41.65***	2.236	0.482	0.12	7.619***
	(0.440)	(0.666)	(0.196)						
Burkina Faso	2.597***	5.204***	1.620*	0.736	25.03***	1.848	0.004	0.04	7.801***
	(0.558)	(0.763)	(0.923)						
Burundi[co]	-2.812**	6.130***	-9.978	0.716	21.43***	1.966[trans]			3.318***
	(1.011)	(1.112)	(7.919)						
Cameroon[co]	2.962***	1.312	-0.359	0.181	1.18	2.262[trans]			4.274***
	(0.998)	(0.912)	(0.274)						
Central African Rep.	-2.288**	7.821***	-8.344*	0.819	40.96***	1.933	0.045	0.51	5.533***
	(0.886)	(1.091)	(4.936)						
Chad	1.133	11.668***	-13.368	0.551	11.05***	1.209	3.316*	1.41	12.801***
	(2.097)	(3.073)	(9.701)						
Congo, Dem. Rep.[nw]	4.419***	2.268***	-12.484**		26.25***				6.687***
	(0.573)	(0.584)	(4.991)						
Congo, Rep.[co]	-0.478	4.989***	-12.329**	0.798	33.52***	1.768[trans]			4.511***
	(0.97)	(1.166)	(5.356)						
Equatorial Guinea	6.513**	27.200***	-12.125**	0.821	26.04***	1.722	0.535	3.25*	33.713***
	(2.602)	(4.380)	(5.638)						
Ethiopia	1.1975	10.145***	1.321	0.689	19.92***	1.905	0.792	6.66***	11.343***
	(1.194)	(1.621)	(2.149)						
Gabon	0.036	4.796***	0.416	0.819	25.66***	2.153	0.403	0.16	4.832***
	(0.599)	(0.811)	(0.671)						

Table continues …

Country	Constant	Dummy	%ΔU	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth in boom periods[N]
Gambia	0.262 (0.662)	4.832*** (0.902)	-7.977* (4.508)	0.748	26.64***	2.329	1.485	1.01	5.094***
Ghana	4.265*** (0.210)	2.734*** (0.257)	0.092 (0.067)	0.928	72.78***	2.058	0.154	0.40	6.999***
Kenya[co]	1.725*** (0.479)	3.243*** (0.512)	-2.522 (4.066)	0.706	20.38***	2.065[trans]			4.968***
Malawi[co]	2.435** (1.109)	3.827*** (1.258)	-18.47*** (2.303)	0.923	64.27***	1.878[trans]			6.262***
Mali	2.1686*** (0.670)	5.153*** (0.957)	1.842 (2.383)	0.623	14.90	1.765	0.123	0.11	7.322***
Mauritius	3.3078)*** (0.296	2.615*** (0.484)	-0.583 (0.398)	0.711	22.15***	2.489	1.356	0.85	5.923***
Mozambique	5.507*** (0.633)	2.932*** (0.877)	-4.537 (3.367)	0.797	22.27***	2.203	0.310	0.01	8.439***
Namibia	2.323*** (0.601)	4.719*** (0.939)	0.166* (0.096)	0.585	12.68***	1.407	1.975	0.08	7.042***
Nigeria[co]	2.967*** (0.688)	3.859*** (0.578)	-8.449 (4.957)	0.972	188.11***	1.755[trans]			6.826***
Senegal[co]	2.539*** (0.460)	2.364*** (0.540)	-6.608* (3.536)	0.803	34.70***	1.743[trans]			4.903***
Sierra Leone	-1.699 (1.931)	10.543*** (2.634)	14.870 (29.303)	0.665	11.24***	2.387	1.421	2.02	8.844***
South Africa[co]	2.637*** (0.243)	1.948*** (0.343)	-0.191** (0.078)	0.838	27.58***	2.187[trans]			4.585***

Table continues …

Country	Constant	Dummy	%ΔU	R^2	F test	Durbin-Watson test	BG test	BP test	Natural rate of growth in boom periods[N]
Sudan	2.843*** (0.736)	4.896*** (0.980)	3.856 (2.640)	0.826	26.84***	1.714	1.183	0.07	7.739***
Swaziland[co]	1.325*** (0.262)	1.757*** (0.321)	-0.649 (0.812)	0.806	22.16***	2.035[trans]			3.082***
Tanzania[pw]	3.018*** (0.652)	3.283*** (0.753)	-0.062 (0.209)	0.264	3.24*	1.591[trans]			6.301***
Togo[co]	0.9375 (1.086)	6.085*** (1.544)	-8.916 (5.454)	0.789	19.98***	1.954[trans]			7.023***
Uganda	5.221*** (0.358)	4.167*** (0.580)	-1.664* (0.894)	0.752	17.20***	1.635	0.089	0.16	9.388***
Zambia	-0.344 (1.003)	6.549*** (1.247)	-0.020 (0.519)	0.609	14.05***	1.901	0.033	13.86***	6.205***
Zimbabwe	-0.769 (1.636)	9.303*** (2.526)	1.472 (2.454)	0.734	15.63***	1.863	0.066	3.52*	8.534***

Note: The natural rate of growth is measured as the constant plus the dummy variable and its significance tested using the Wald test. This is an extension of the Thirlwall (1969) specification from Equation 4.2. The country specific dummy variables for structural breaks used in Table 4.3 are therefore also included in these estimates. The dependent variable is GDP growth.
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
[co] Cochrane-Orcutt iterative procedure used to correct for autocorrelation
[pw] Prais-Winsten transformation used to correct for autocorrelation when Cochrane-Orcutt iterative procedure is not appropriate
[nw] Newey-West heteroscedasticity and autocorrelation consistent (HAC) standard errors used to correct for autocorrelation and heteroscedasticity
[trans] is the transformed Durbin-Watson statistic from the Cochrane-Orcutt iterative procedure

For 25 out of 31 countries, the constant and the dummy were positive and jointly significant at the 99% confidence level. This provides evidence of the endogeneity of the natural rate of growth. For 6 countries (Burundi, Central African Republic, Republic of Congo, Sierra Leone, Zambia and Zimbabwe) the intercept was negative. Caution is therefore needed when interpreting the results from these countries, however when the intercept and dummy are combined, in all cases the natural rate of growth in boom periods is above the natural rate of growth estimate based on Equation 4.2. For Swaziland, as we could not estimate the natural rate of growth using the first differenced GDP growth, we proceed with the specification using GDP growth however these results should not be taken at face value due to problems related to spurious regressions.

The absolute difference between the natural rate of growth based on Equation 4.2 and the natural rate of growth in boom periods can be seen in Table 4.6, alongside the sensitivity of the natural rate of growth to the actual rate of growth. As mentioned earlier, caution needs to be taken when interpreting the results for the 6 countries which had a negative intercept for Equation 4.3. The averages are therefore given for all countries as well as the subsample of countries which does not include the 6 mentioned countries.

The average natural rate of growth in boom periods for all countries was 7.8 while that for the subsample was 8.2. The average absolute difference between the natural rate of growth estimated using Equation 4.2 and the natural rate of growth in boom periods was 2.9 for all countries and 2.9 for the subsample. The increase in the natural rate of growth in boom periods to the actual rate of growth ranged from 8% for Cameroon to 330% for Burundi. The average for all countries was 64.8% while the average for the subsample was 48.7%.

As the results from the time series analysis are only indicative due to the limited time dimension, we analyse them together with the results from the panel data estimates which are given in the next section.

Table 4.6; The change in the natural rate of growth in boom periods

Country	Thirlwall specification	Natural rate in boom periods	Absolute difference	% difference
Angola	7.887	13.699	5.812	73.691
Botswana	4.947	7.619	2.672	54.013
Burkina Faso	5.674	7.801	2.127	37.487
Burundi	*0.772*	*3.318*	*2.546*	*329.793*
Cameroon	3.948	4.274	0.326	8.257
Central African Rep.	*3.222*	*5.533*	*2.311*	*71.726*
Chad	6.861	12.801	5.94	86.576
Congo, Dem. Rep.	5.856	6.687	0.831	14.191
Congo, Rep.	*2.972*	*4.511*	*1.539*	*51.783*
Equatorial Guinea	16.084	33.713	17.629	109.606
Ethiopia	6.735	11.343	4.608	68.419
Gabon	2.677	4.832	2.155	80.501
Gambia	3.143	5.094	1.951	62.074
Ghana	5.216	6.999	1.783	34.183
Kenya	3.389	4.968	1.579	46.592
Malawi	4.236	6.262	2.026	47.828
Mali	4.812	7.322	2.51	52.161
Mauritius	4.368	5.923	1.555	35.600
Mozambique	7.115	8.439	1.324	18.609
Namibia	4.616	6.953	2.337	50.628
Nigeria	4.818	6.826	2.008	41.677
Senegal	3.629	4.903	1.274	35.106
Sierra Leone	*4.099*	*8.844*	*4.745*	*115.760*
South Africa	3.571	4.585	1.014	28.395
Sudan	5.607	7.739	2.132	38.024
Swaziland	2.197	3.082	0.885	40.282
Tanzania	4.729	6.301	1.572	33.242
Togo	3.837	7.023	3.186	83.034
Uganda	6.864	9.388	2.524	36.772
Zambia	*3.817*	*6.205*	*2.388*	*62.562*
Zimbabwe	*3.264*	*8.534*	*5.27*	*161.458*
Average	4.869	7.791	2.921	64.840
Average less 6 countries (market in italic)	5.313	8.183	2.870	48.678

4.3. Panel Data Estimation Results

The estimation results for Equations 4.2 to 4.3 using panel data analysis are reported in Table 4.7. Fixed effects or random effects are used to estimate the natural rate of growth for 11 subgroups, the three country groups based on the level of economic development as well as the overall pool of countries. Estimations using the IV approach are not reported for the subgroups due to the difficulty in finding appropriate instruments as a result of poor data availability for the sub-Saharan African region. As mentioned before, IV provides inconsistent estimates, even in the presence of a large sample size when instruments are weak (Wooldridge, 2007). We therefore only apply the IV approach to the overall pool of countries, however caution is needed due to the problems arising from the use of weak instruments. The lags of the variables are used as instruments.

The results from the panel data estimates show that the natural rate of growth was endogenous for all 14 subgroups as well as the overall pool of countries. There also appears to be very little difference between the natural rate estimated using the random or fixed effects approach and that using the IV approach as the natural rate of growth was 4.9 and 5.2 respectively. The natural rate of growth for the full sample increases to 8.4 and 8.9 in the boom periods using random effects and IV estimation methods respectively. The problems arising from the endogeneity of the unemployment rate therefore does not seem to be relevant.

Table 4.7; Panel data results for the endogeneity of the natural rate of growth based on Equation 4.2 and 4.3

Country	Constant	Dummy	Δ%U	R^2 overall	N	Fixed or random effects	Time effects	Time effects (P value)	Natural rate of growth[N]
South Africa and Swaziland	2.631*** (0.265)		-0.151 (0.184)	0.016	42	Random	No	0.266	2.631***
Endogeneity test: South Africa and Swaziland	1.210*** (0.286)	2.482*** (0.380)	-0.022 (0.130)	0.529					3.693***
Zambia, Zimbabwe, Namibia and Botswana	2.927*** (0.021)		0.129 (0.106)	0.0027	84	Fixed[robust]	No	0.893	2.927***
Endogeneity test: Zambia, Zimbabwe, Namibia and Botswana	-2.295 (1.117)	8.219** (1.771)	-0.049 (0.047)	0.557					5.925***
Angola, Mozambique and Congo, Dem. Rep.	6.381*** (1.147)		-22.396*** (1.968)	0.616	63	Random[robust]	Yes	0.009***	4.547***
Endogeneity test: Angola, Mozambique and Congo, Dem. Rep.	-2.642*** (0.939)	9.211*** (0.769)	-26.753*** (2.011)	0.831					6.569***
Ethiopia and Uganda	6.878*** (0.060)		-0.679 (0.861)	0.003 0.560	42	Random[robust]	No	0.485	6.878***
Endogeneity test: Ethiopia and Uganda	3.525* (1.991)	6.702** (2.833)	-1.074 (1.332)						10.227***
Chad and Central African Rep.	5.037*** (0.002)		-25.109*** (0.443)	0.188	42	fixed[robust]	No	0.568	5.0375***
Endogeneity test: Chad and Central African Rep.	1.050 (1.596)	8.236 (3.351)	-11.506*** (0.235)	0.467					9.287***
Cameroon and Gabon	2.511*** (0.509)		0.294 (0.496)	0.008	42	Random	No	0.282	2.5111***
Endogeneity test: Cameroon and Gabon	-0.887* (0.533)	5.284*** (0.665)	0.259 (0.311)						4.396***
Nigeria and Togo	4.228*** (0.994)		-18.108** (8.968)	0.078	42	Fixed	No	0.395	4.228***
Endogeneity test: Nigeria and Togo	0.900 (1.143)	7.425*** (1.753)	-11.520 (7.649)	0.405					8.326***

Table continues …

Country	Constant	Dummy	Δ%U	R^2 overall	N	Fixed or random effects	Time effects	Time effects (P value)	Natural rate of growth[N]
Ghana and Burkina Faso	8.744*** (1.690)		-0.369 (0.310)	0.604	42	Random	Yes	0.061*	8.744***
Endogeneity test: Ghana and Burkina Faso	5.614*** (1.518)	6.227*** (1.590)	-0.023 (0.253)	0.781					11.840***
Senegal, Sierra Leone and Gambia	3.265*** (0.155)		-11.603 (9.184)	0.025	63	Random[robust]	No	0.063*	3.265***
Endogeneity test: Senegal, Sierra Leone and Gambia	-0.858 (1.803)	7.530** (3.127)	7.022 (11.690)	0.412					6.672***
Tanzania and Mali	5.068*** (0.239)		-0.598*** (0.175)	0.016	42	Random[robust]	No	0.907	5.068***
Endogeneity test: Tanzania and Mali	2.799*** (0.347)	4.343*** (0.618)	0.043 (0.183)	0.640					7.142***
Kenya, Malawi and Congo, Rep.	2.895*** (0.381)		-23.196*** (2.645)	0.557	63	Random	No	0.535	2.895***
Endogeneity test: Kenya, Malawi and Congo, Rep.	0.243 (0.464)	4.510*** (0.627)	-17.039*** (2.134)	0.762					4.753***
Low income economies	6.886*** (1.776)		-1.723 (1.438)	0.147	336	Fixed[robust]	Yes	0.000	6.886***
Endogeneity test: low income economies	1.288 (0.757)	7.362*** (1.197)	-0.442 (1.322)	0.466					8.650***
Low income economies (excl. Congo, Dem. Rep.)	6.909*** (2.190)		-1.679 (1.460)	0.127	315	Random[robust]	Yes	0.000	6.909***
Endogeneity test: low income economies (excl. Congo, Dem. Rep.)	4.554*** (1.665)	7.737*** (1.177)	-0.330 (1.327)	0.465					12.291***
Lower middle income economies	2.767 (2.261)		0.045 (0.091)	0.201	168	Random[robust]	Yes	0.013	2.767
Endogeneity test: lower middle income economies	-0.892 (1.932)	4.882*** (0.872)	0.104 (0.128)	0.442					3.99***

Table continues …

Country	Constant	Dummy	Δ%U	R^2 overall	N	Fixed or random effects	Time effects	Time effects (P value)	Natural rate of growth[N]
Upper middle income economies	4.553*** (0.690)		-0.026 (0.082)	0.280	126	Randon[robust]	Yes	0.000	4.553***
Endogeneity test: upper middle income economies	1.971* (1.105)	5.367*** (1.307)	0.171** (0.086)	0.483					7.338***
Upper middle income economies (excl. Angola and Gabon)	3.726*** (1.247)		-0.022 (0.113)	0.420	84	Random	Yes	0.000	3.726***
Endogeneity test: upper middle income economies (excl. Angola and Gabon)	2.157*** (1.012)	3.229*** (0.513)	0.040 (0.091)	0.648					5.386***
All countries	4.876*** (0.766)		-0.096 (0.152)	0.084	651	Random[robust]	Yes	0.000***	4.876***
Endogeneity test: all countries	1.213* (0.703)	7.142*** (0.902)	0.100 (0.130)	0.364					8.355***
IV	5.204*** (1.325)		2.508** (1.055)	0.012	620	Random	Yes	0.001***	5.204***
Endogeneity test: IV	1.357 (1.050)	7.637*** (0.512)	1.346* (0.776)	0.313					8.994***

Note: The constant is the natural rate of growth. The natural rate of growth in boom periods is the constant plus the dummy variable for periods when the actual rate of growth is above the natural rate of growth.
Standard errors are in parenthesis
[robust] are heteroscedasticity consistent standard errors
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

4.4. Discussion of the Results

A comparison is made in Table 4.8 between the time series and panel data estimates. Despite the problems related to the bias arising from the endogeneity of the unemployment rate, the results are robust. The natural rate of growth using the IV approach is 5.2 and increases to 8.9 during the boom periods. The difference in the natural rate of growth in boom years versus years with growth below the natural rate is therefore 72.8% which is very close to the estimated difference using the total pool of countries (71.3%). The change in the natural rate of growth using time series techniques is slightly smaller at 64.8%. Our results therefore provide robust evidence, across different estimation techniques on the endogeneity of the natural rate of growth for the sub-Saharan African countries included in the study.

Table 4.8; Comparison of the time series and panel data results

		Natural rate of growth		Natural rate of growth in boom periods			
Group	Country	A. Time series	B. Panel	C. Time series	D. % increase	E. Panel	F. % increase
1	South Africa	3.571	2.631	4.585	28.395	3.693	40.364
	Swaziland	2.197	2.631	3.082	40.282	3.693	40.364
2	Botswana	4.947	2.927	7.619	54.013	5.925	102.425
	Namibia	4.616	2.927	6.953	50.628	5.925	102.425
	Zambia	3.817	2.927	6.205	62.562	5.925	102.425
	Zimbabwe	3.264	2.927	8.534	161.458	5.925	102.425
3	Angola	7.887	4.547	13.699	73.691	6.569	44.468
	Congo, Dem. Rep.	5.856	4.547	6.687	14.191	6.569	44.468
	Mozambique	7.115	4.547	8.439	18.609	6.569	44.468
4	Ethiopia	6.735	6.878	11.343	68.419	10.227	48.691
	Uganda	6.864	6.878	9.388	36.772	10.227	48.691
5	Central African Rep.	3.222	5.037	5.533	71.726	9.287	84.375
	Chad	6.861	5.037	12.801	86.576	9.287	84.375
6	Cameroon	3.948	2.511	4.274	8.257	4.396	75.069
	Gabon	2.677	2.511	4.832	80.501	4.396	75.069
7	Nigeria	4.818	4.228	6.826	41.677	8.326	96.925
	Togo	3.837	4.228	7.023	83.034	8.326	96.925
8	Burkina Faso	5.674	8.744	7.801	37.487	11.84	35.407
	Ghana	5.216	8.744	6.999	34.183	11.84	35.407
9	Gambia	3.143	3.256	5.094	62.074	6.672	104.914
	Senegal	3.629	3.256	4.903	35.106	6.672	104.914
	Sierra Leone	4.099	3.256	8.844	115.76	6.672	104.914
10	Mali	4.812	5.068	7.322	52.161	7.142	40.923
	Tanzania	4.729	5.068	6.301	33.242	7.142	40.923
11	Congo, Rep.	2.972	2.895	4.511	51.783	4.753	64.179
	Kenya	3.389	2.895	4.968	46.592	4.753	64.179
	Malawi	4.236	2.895	6.262	47.828	4.753	64.176
Low income economies			6.886			8.65	25.617
Low income economies (excl. Congo, Dem. Rep.)			6.909			12.291	77.898
Lower middle income economies			2.767			3.99	44.199
Upper middle income economies			4.553			7.338	61.168
Upper middle income economies (excl. Angola and Gabon)			3.726			5.386	44.551
All countries		4.870[A]	4.876	7.791[A]	64.840	8.355	71.349
All countries (IV)			5.204			8.994	72.828

Note: [A] is the time series average for all 31 countries

When analysing the sensitivity in the natural rate of growth using the time series results, we split the sample into countries which had a sensitivity above and below the average sensitivity for the region. The countries with a sensitivity above the average of 64.8% were Burundi (329.7%), Zimbabwe (161.5%), Sierra Leone (115.7%), Equatorial Guinea (109.6%), Chad (86.6%), Togo (83%), Gabon (80.5%), Angola (73.6%), Central African Republic (71.7%) and Ethiopia (68.4%). About 60% of these countries experienced some form of conflict or political instability. Burundi, Sierra Leone, Chad and Angola all faced a civil war while Ethiopia went to war with Somalia and Eritrea. There were several military coups in the Central African Republic following independence from France in 1960. The conflict and political instability in these countries no doubt contributed to their low level of economic growth and development. According to Collier et al (2003), there is bi-directional causality between low economic development and civil war, described in the literature as the "conflict trap".

The negative effects of civil war and political instability on investment (Alesina et al, 1992; Serven, 1998; Collier et al, 2003) indicates that these countries may have been operating below full capacity and therefore had a stronger response to an increase in domestic and foreign demand during the boom. More stable countries may have a higher rate of resource utilization.

The remaining countries; Zimbabwe, Equatorial Guinea, Togo and Gabon all had presidents who held power for over three decades[54]. Unsurprisingly, the majority of these countries who had a sensitivity higher than the average for the region, ranked low in the Worldwide Governance Indicators (World Bank, 2015). This includes the measures for control of corruption, the rule of law and government effectiveness where the countries concerned ranked below 20 out of 100, with the exception of Gabon and Ethiopia who ranked between 25 and 40.

We aim to further understand the relationship between the percentage increase in the natural rate of growth during the boom periods and key governance and institutional quality indicators by making use of correlation analysis. The results are shown in Table 4.9.

The sensitivity of the natural rate of growth during the boom period had a statistically significant negative correlation using both Pearson's correlation and Spearman's rank correlation with voice and accountability, government effectiveness, regulatory quality and the rule of law. The effect of demand on the natural rate of growth is thus mediated by institutions. The natural rate of growth during the boom period is lower when there is an improvement in the institutional quality indicators. This may be due to the negative effect that poor governance has on growth and development (Campos and Nugent, 1999; Kaufmann et al, 1999; Fayissa and Nsiah, 2010), leading to underutilised resources and low levels of productivity, which increases the degree to which the natural rate of growth can respond to demand changes.

[54] Equatorial Guinea, Gabon and Zimbabwe have faced controversy regarding election rigging.

Table 4.9; Correlation results for the sensitivity in the natural rate of growth and key development and institutional indicators

	Increase in the boom		Increase in the boom (excl. Angola, Gabon and Congo. Dem. Rep.)	
Indicator	Pearson	Spearman	Pearson	Spearman
GDP per capita	-0.033 (0.869)	-0.080 (0.691)	-0.196 (0.357)	-0.364* (0.080)
Human development index	-0.137 (0.496)	-0.112 (0.578)	-0.355* (0.088)	-0.373* (0.072)
Voice and accountability	-0.352* (0.071)	-0.397** (0.040)	-0.436** (0.033)	-0.539*** (0.006)
Political stability and absence of violence	-0.056 (0.779)	-0.036 (0.856)	-0.174 (0.415)	-0.232 (0.275)
Government effectiveness	-0.331* (0.091)	-0.322* (0.101)	-0.430** (0.035)	-0.389* (0.059)
Regulatory quality	-0.389** (0.047)	-0.370* (0.057)	-0.499** (0.013)	-0.476** (0.018)
Rule of law	-0.347* (-0.075)	-0.305 (0.121)	-0.472** (0.019)	-0.434** (0.033)
Control of corruption	-0.242 (0.222)	-0.186 (0.351)	-0.322 (0.124)	-0.196 (0.357)

Note: P values are given in parenthesis
The Worldwide Governance Indicators are measured using the rank (World Bank, 2015)
Pearson refers to Pearson correlation coefficient. Spearman refers to Spearman's rank correlation coefficient
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

70% of the countries who had a sensitivity higher than the average were categorised as low income economies (World Bank, 2015). Angola and Gabon are categorised as upper middle income countries while Equatorial Guinea is classified as a high income economy. Caution is needed when using this measure of economic development for Angola, Gabon and Equatorial Guinea as they are all oil exporting economies, with oil rents accounting for 35%, 42% and 53% of GDP respectively (World Bank, 2015). These countries have high levels of inequality with a Gini index of over 46 in Angola and 40.6 in Gabon, in addition to huge poverty rates of over 70% in Angola and Equatorial Guinea[55] and 19.5% in Gabon at the USD2 a day poverty line (World Bank, 2015). The income level of these countries is therefore not a good indicator of their economic development, so we exclude them from the upper middle income category.

Table 4.9 shows the correlation results obtained for the increase in the natural rate of growth during the boom period and the level of economic development measured by GDP per capita and the

[55] For Equatorial Guinea, the poverty headcount ratio as a percentage of the population used the national poverty line due to a lack of data on the USD2 a day poverty criteria.

human development index. We find a significant negative correlation for both when we exclude the outlier countries, i.e. Angola, Gabon and the Democratic Republic of Congo.

Low levels of economic development is linked to low productivity which enables remarkable increases in productivity with relatively small increases in investment. Low income economies also have low levels of industrialisation and therefore face massive potential for growth as governed by the Verdoorn-Kaldor laws. There is a long understanding in the heterodox economic growth and development literature that there is a causal relationship between growth in the manufacturing sector and growth in GDP (Kaldor, 1966) as the former is characterised by increasing returns to scale.

In addition, industries in low income countries are more labour intensive. This contributes to the higher sensitivity of the natural rate of growth as there are large decreases in unemployment during boom periods. This may also help explain the negative constant when testing the endogeneity of the natural rate of growth.

As economic development, measured by GDP per capita is negatively correlated with the size of the informal sector (International Labour Organisation, 2012), we expect the natural rate of growth to be higher in low income countries as there is large participation of the labour force in the informal and subsistence economy which can easily move into the formal sector during boom periods. The informal economy represents over 80% of the labour force in sub-Saharan Africa (United Nations Economic Commission for Africa, 2015). There is poor individual country data on the size of the informal and subsistence economies for low income countries however the majority of the sub-Saharan African economies are low income. Of course, the degree of labour mobility will affect the degree of change in the natural rate of growth during the boom, for example there may be less labour mobility in South Africa due to the legacy of apartheid which legally discriminated and excluded individuals from certain social and economic activities, and its effects persist even during the post-apartheid era (Bhorat and Oosthuizen, 2005).

The time series results for individual countries reported above are consistent with those obtained from the panel analysis for the groups corresponding to different income levels. When the countries were grouped from low income to upper middle income, we see that the group of low income countries had the highest response to domestic and foreign demand in the boom periods as the natural rate of growth increased by 77.8%.

The specification which excludes the Democratic Republic of Congo is used as the country has been plagued with war for several decades. Its inclusion may therefore lead to biased results. The low response of the natural rate of growth to the actual rate of growth in the Democratic Republic of Congo is expected due to the intensity and prolonged period of war the country has experienced resulting in reduced investment which is further exasperated by the increased rate of depreciation of the fixed capital stock, as a consequence of the destructive effect of civil war (Imai and Weinstein, 2000). It is therefore possible that the country may have lost most of its productive capacity and therefore is limited in its ability to respond to an increase in demand. This may also explain why the indicator for political stability and the absence of violence or terrorism was not significant using Pearson's correlation and Spearman's rank correlation.

The percentage increase in the natural rate of growth for lower middle income economies is 44.2% and 44.6% for upper middle income economies. The results indicate a non-linear relationship between the natural rate of growth and its response to the actual rate of growth in the boom periods. The sensitivity appears to be higher for low income countries (77.8%), it decreases for lower middle income countries (44.2%) and then levels off for upper middle income countries (44.6%). These results indicate that the responsiveness of the natural rate of growth to an increase in demand is L shaped for developing countries as it is higher the lower the level of economic development.

We do not include any high income economies in our analysis however when comparing our results with those from Leon-Ledesma and Thirlwall (2002) who only include high income economies in their analysis, we find that the sensitivity in the natural rate of growth is slightly higher for high income economies at 50.7% compared to middle income economies. The non-linear relationship on all economies for the sensitivity of the natural rate of growth and the level of economic development may therefore be U shaped. Future research looking into the differences in the sensitivity of the natural rate of growth to demand for all countries is needed.

4.5. Comparison with Other Studies

As no previous research on the natural rate of growth has been carried out for low income countries or the sub-Saharan African region, the results from the natural rate of growth as well as the change in the natural rate of growth in boom periods is compared to the results obtained for other developing countries as well as the OECD, i.e. Leon-Ledesma and Thirlwall (2002) for 15 OECD countries, Vogel (2007) for 11 Latin American countries, Libanio (2009) for 10 Latin American countries and Dray and Thirlwall (2011) for 10 Asian countries. The full table with the summary of results for the individual countries analysed in the above mentioned studies can be seen in Appendix D. Table 4.10 reports the average natural rate of growth and its change during the boom periods.

Table 4.10; Comparison of averages with other studies

	Region	Thirlwall specification	Natural rate of growth in boom periods	% increase
All countries – time series	Sub-Saharan	4.870	7.791	64.840
All countries – panel	Africa	4.876	8.355	71.349
Leon-Ledesma and Thirlwall (2002)	OECD	3.535	5.363	50.747
Vogel (2009)	Latin America	3.511	5.704	71.85
Libanio (2009)	Latin America	2.727	4.542	76.289
Dray and Thirlwall (2011)[N]	Asia	6.436	8.2	30.177

Note: Dray and Thirlwall (2011) found the change in the natural rate of growth in the boom to be 30% for a selection of 10 Asian countries. Included in this sample were Hong Kong, Japan, Singapore, South Korea and Taiwan which are not considered as less developed countries. The sensitivity of the natural rate of growth is therefore much lower than that estimated for developing countries.

No low income countries are included in the studies by Vogel (2009) and Libanio (2009), as categorised by the World Bank (2015), however caution is needed when making inferences about the results as many of the countries in Latin America categorised as upper middle income countries and high income countries are natural resource dependent with high levels of inequality. Per capita income may therefore not be a good economic indicator for economic development. However, the comparison is still insightful as it still provides evidence for the non-linear relationship between the natural rate of growth and its response to domestic and foreign demand.

The change of our estimated natural rate of growth during the boom periods averaged 64.8% in the time series approach and 71.3% in the panel appears reasonable when compared to the results obtained for other developing countries as the average change ranged from 71.8% to 76.3% for Latin American countries (Vogel, 2009; Libanio, 2009). This is higher than the change estimated for the OECD of 50.7%. This is additionally consistent with the literature as we expect the natural rate of growth to be higher in less developed countries due to the large size of the informal sector, low levels of development and productivity and higher degree of labour intensive industries.

4.6. Robustness Test: The Verdoorn Kaldor Relationship

In developing regions such as sub-Saharan Africa which are characterised by high surplus labour in the form of high unemployment and underemployment rates, growth in output may be unresponsive to changes in the labour force. As the natural rate of growth is defined as the sum of the growth in the labour force and growth in labour productivity, we apply an alternative specification to empirically test if growth in labour productivity is endogenous to the actual rate of growth. This relationship is also known as Verdoorn's law (1949).

As our objective is to determine the direction of causality between labour productivity and changes in demand, we carry out Granger causality analysis within a panel VAR framework. Please see section 6.2 for a detailed description of the estimation methodology.

The variables included in the analysis are growth in productivity and GDP growth, y. Data for all 31 countries used in the Okun (1962) and Thirlwall (1969) specification to test the endogeneity hypothesis of the natural rate of growth are included for the 1991 to 2014 period. We carry out panel unit root tests and strongly reject the null hypothesis that all countries in the panel contain a unit root. Detailed results from the panel unit root tests are shown in Appendix O. The results from the panel VAR model are shown in Table 4.11.

Table 4.11; Summary of panel VAR results for, productivity and, y 1991 to 2014

	productivity	productivity
$productvity_{t-1}$	0.098	0.084
	(0.182)	(0.159)
y_{t-1}	0.618***	0.495**
	(0.235)	(0.196)
Trend		0.000
		(0.000)
	y	y
$productvity_{t-1}$	0.216	0.155
	(0.135)	(0.148)
y_{t-1}	0.480**	0.415**
	(0.200)	(0.187)
Trend		0.000
		(0.000)
Lag order	1	1
Instrument	4	4
MBIC	-64.098	-58.841
MAIC	-12.205	-6.949
MQIC	-32.471	-27.214
J statistic	11.794	17.050
J statistic P value	0.462	0.147
No of observations	558	558
No of cross sections	31	31
LM test for autocorrelation (P value)	0.923	0.927
Stability condition	Stable	Stable
Panel Granger Causality (P values)		
$y \rightarrow productivity$	0.009***	0.012**
$productvity \rightarrow y$	0.110	0.296

Note: Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
The stability graphs can be seen in Appendix S

A lag order of 1 is chosen where the MBIC, MAIC and MQIC were minimised. The results from the Granger causality analysis provides evidence of unidirectional causality running from the actual rate of growth to growth in labour productivity. This result is consistent with the inclusion of a trend. This provides additional support, that labour productivity is endogenous to demand changes. There is a causal relationship between growth in output and growth in productivity due to static, dynamic and macro increasing returns to scale also known as Verdoorn's law. The results are consistent with those obtained by Wells and Thirlwall (2003) for the African region.

It should be noted that the estimates may be biased as we do not control for capital accumulation due to poor data availability. However, within our panel VAR model, the relationship between growth in productivity and growth in output is stable even in the presence of omitted variables.

4.7. Concluding Remarks

The research contributes to understanding the sensitivity of the natural rate of growth to domestic and foreign demand for developing countries, by integrating a political economy and institutionalist approach to the post-Keynesian theory. It adds to our understanding of the relevance of demand for low income economies in particular, as no previous research has been done on this group of countries. The effect of demand on growth is further mediated by institutions.

We test the endogeneity hypothesis for the natural rate of growth, i.e. its dependence on demand for 31 sub-Saharan African countries using time series and panel data for the 1991 to 2012 period. Evidence in favour of the endogeneity of the natural rate of growth is found for all 31 countries using time series analysis.

As caution is needed when interpreting the time series results, due to the limited degrees of freedom, we make use of Seemingly Unrelated Regressions (SUR) to pool countries which share similar parameters. Different country combinations are tested and only countries with the same parameters, tested using the Wald test, are grouped. Three additional subgroups are used based on respective country income levels, i.e. low income, lower middle income and upper middle income as defined by the World Bank (2013).

The results from the panel data estimates are consistent with the time series results, as evidence of the endogeneity of the natural rate of growth is found for all 11 subgroups, the three additional subgroups based on income levels, as well as for the overall pool of countries. The results are robust across different estimation techniques, i.e. OLS, TSLS, fixed versus random effects panel estimation and IV techniques.

Due to high unemployment rates and disguised unemployment, demand in low income economies may be less responsive to changes in the labour supply. As a robustness test we estimate Verdoorn's law (1949) within a panel VAR model. The results from our panel Granger causality analysis provides evidence of unidirectional causality running from the actual rate of growth to growth in productivity. This provides strong evidence for the 31 countries included in the analysis, that there is a causal relationship between growth in output and growth in productivity due to static, dynamic and macro increasing returns, i.e. Verdoorn's law.

The result that growth in productivity is endogenous to changes in demand, provides additional support for the endogeneity hypothesis pertaining to the natural rate of growth. This is of significance as post-Keynesian economists have demonstrated that if the natural rate of growth is endogenous to demand, hence the actual rate of growth, then changes in demand might matter for economic growth and development in the long run as well as the short run (Leon-Ledesma and Thirlwall, 2002). The results obtained are additionally in line with the literature which shows a higher natural rate of growth for less developed countries compared with developed countries (Vogel, 2009; Libanio, 2009).

We further contribute to the understanding of the relevance of demand for developing countries by distinguishing between low income, lower middle income and upper middle income economies in the case of sub-Saharan Africa. Caution is needed when using the World Bank income categories based on per capita income due to large levels of inequality and poverty which make this a poor measure for some countries such as Angola, Gabon and Equatorial Guinea. The results indicate that the sensitivity of the natural rate of growth to demand shocks for developing countries is L shaped. The sensitivity of the natural rate of growth is higher the lower the level of economic development, however it decreases at an increasing rate. This can be seen in the panel results for the sensitivity of the natural rate of growth which was 77.8% for low income countries, 44.2% for lower middle income countries and 44.6% for upper middle income countries.

There are several reasons for a higher sensitivity in the natural rate of growth for low income economies. Firstly, many of these countries have been plagued with some sort of political instability or conflict. Collier et al (2003) have provided evidence of the "conflict trap" where low economic development leads to conflict and vice versa. As conflict and political instability reduce growth partly through the negative effect on investment, it is very possible these countries had spare productive capacity which easily allowed them to respond to an increase in demand.

Other factors such as poor governance, as measured by the Worldwide Governance Indicators (World Bank, 2015), may have contributed to the low level of economic growth and development.

Low income economies are characterised by low levels of industrialisation and therefore display massive potential for growth as governed by the Verdoorn-Kaldor laws, which state that there is a causal relationship between growth in the manufacturing sector and growth in GDP (Kaldor, 1966). Small increases in investment offer massive potential for improvements in productivity. Where industries do exist, they are usually labour intensive, further contributing to the responsiveness of the natural rate of growth to aggregate demand during the boom period.

Finally, the natural rate of growth is higher in low income countries due to the large participation of the labour force in the informal and subsistence economy which can easily move into the formal sector during boom periods. This is the case for low income economies as there is a negative correlation between the level of economic development and the size of the informal economy (International Labour Organisation, 2012).

These estimations give support to further estimating a demand constrained growth model for sub-Saharan Africa. In order to determine if demand matters for long term economic growth, we propose to test Thirlwall's (1979) balance of payments constrained growth model. This is done in the next chapter.

Chapter 5

5. THE BALANCE OF PAYMENTS CONSTRAINED GROWTH

The results from chapter 4 provided empirical evidence suggesting that demand matters for economic growth both in the short and long run. Exports are considered as the only true component of autonomous demand. An increase in exports, working through the Hicks "super multiplier" results in the faster growth of other components of demand (Thirlwall, 1997). We therefore test the balance of payments constrained growth model originally developed by Thirlwall (1979) as it is a long run demand-led model. The original balance of payments constrained growth rate is given by the income elasticity of demand for exports multiplied by the growth in world income, divided by the income elasticity of demand for imports.

The balance of payments constrained growth model is preferred to other export-led growth models as its emphasis is on both the demand for exports and imports, as captured by the income elasticities of demand. These in turn depend on non-price based factors.

There have been several extensions to the original model to account for capital flows and the terms of trade (Thirlwall and Hussain, 1982), external debt financing (Elliott and Rhodd, 1999) and sustainable debt accumulation (Moreno-Brid, 1999). There are two empirical studies testing the balance of payments constrained growth rate for the sub-Saharan region (Hussain, 1999; Perraton, 2003). None however test the most comprehensive model accounting for sustainable debt accumulation, interest payments abroad and the terms of trade (Moreno-Brid, 2003).

An empirical study applying this extended model is necessary, as 33 of the 39 countries described as heavily indebted poor countries are in sub-Saharan Africa (World Bank, 2015). In addition, majority of the countries depend on the production of primary products in international markets making the terms of trade effects more pronounced.

This chapter therefore addresses the research sub-question, (iii) Is the balance of payments constrained growth model still relevant for sub-Saharan Africa? If so, which model best fits the growth experience of the region. We address the question by estimating six different balance of payments constrained growth models, starting with the original version (Thirlwall, 1979) to the most comprehensive model (Moreno-Brid, 2003).

Section 5.1 outlines the data and methodology used to estimate the model for the region. Due to uncertainty regarding the stationarity of the variables as a result of structural breaks in the data, we apply an Autoregressive Distributive Lag (ARDL) model. The results obtained from estimating the import and export demand functions as well as the estimated balance of payments constrained growth model are given in section 5.2.

5.1. Data and Methodology

There have been several extensions to the original balance of payments constrained growth model. The chosen model for the sub-Saharan African region is the Moreno-Brid (2003) modification which allows for sustainable debt accumulation, interest payments abroad and the terms of trade. As far as we are aware, there are no current papers which test this version of the model for the region. Below is an outline of the data, model and the methodology used to estimate and test the balance of payments constrained growth model.

5.1.1. Data

Data covering the 1960 to 2014 period is used in the analysis. The time period used differs for individual countries due to data availability. The variables used are exports of goods and services, imports of goods and services, GDP, world income, import price index, export price index, interest payments on external debt and the real effective exchange rate. Please see Appendix A for a full description of the data and sources used.

5.1.2. The Empirical Model

In line with Thirlwall and Hussain (1982) and Moreno-Brid (2003), the starting point of the extended model of the balance of payments constrained growth model is the balance of payments accounting identity in disequilibrium which will be modified accordingly to accommodate for sustainable debt accumulation, interest rate payments and the terms of trade.

$$P_d X + F P_d = P_f M E \qquad \text{(Equation 5.1)}$$

Where P_d, is the price of exports in the domestic currency, X, is the volume of exports, F, is the current account deficit in real terms so that FP_d, is nominal capital flows to finance the deficit, P_f, is the price of imports in foreign currency, M, is the volume of imports and E, is the exchange rate measured as the domestic price of foreign currency[56].

Taking the first difference of the variables in logarithmic form yields,

$$\theta(p_d + x) + (1-\theta)(f + P_d) = p_f + m + e \qquad \text{(Equation 5.2)}$$

[56] For simplicity the nominal exchange rate is assumed to be fixed and equal to one (Moreno-Brid, 2003).

where θ, and $(1-\theta)$, represent the share of exports and capital flows as a proportion of total receipts respectively. Therefore $\theta = P_d X/R$ and $(1-\theta) = FP_d/R$, where R, is total receipts which can also be expressed as the import bill financed by export earnings and capital flows. Lower case letters denote growth rates.

Equation 5.2 is modified to include sustainable debt accumulation and interest rate payments abroad (Moreno-Brid, 2003). We account for interest payments abroad by subtracting interest payments from capital flows,

$$\theta(p_d + x) - \theta_1(p_d + r) + (1 - \theta + \theta_1)(f + P_d) = p_f + m + e \quad \text{(Equation 5.3)}$$

where r, is the growth rate of real net interest payments abroad and θ_1, is the share of foreign exchange used for interest payments abroad. Corresponding to sustainable debt accumulation in the long run, we assume that the current account deficit to GDP ratio is constant, hence we set f=y[57]. Substituting the growth of imports and exports from Equations 2.40 and 2.41, setting f=y and solving for the growth of income[58],

$$*\, y_{BSDART} = \frac{\theta\varepsilon z - \theta_1 r + (\theta\eta + \psi + 1)(p_d - p_f - e)}{\pi - (1 - \theta + \theta_1)} \quad \text{(Equation 5.4)}$$

where $*y_{BSDART}$, is the balance of payments constrained growth rate with sustainable debt accumulation, interest rate payments abroad and the terms of trade. The growth rate is stable if the income elasticity of demand for imports is equal to or greater than 1, i.e. $(\pi \geq 1)$. If this condition is not met, the growth rate is stable under the strong assumption that exogenous shocks do not move the debt ratios from their stable path (Barbosa-Filho, 2001).

Under the assumption of constant relative prices[59], Equation 5.4 reduces to,

$$y_{BSDART} = \frac{\theta x - \theta_1 r + (\psi + 1)(p_d - p_f - e)}{\pi - (1 - \theta + \theta_1)} \quad \text{(Equation 5.5)}$$

If the terms of trade are neutral and the Marshall Lerner condition is met, i.e. $\psi = -1$ then Equation 5.5 reduces to,

$$y_{BSDAR} = \frac{\theta x - \theta_1 r}{\pi - (1 - \theta + \theta_1)} \quad \text{(Equation 5.6)}$$

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[57] Following Moreno-Brid (2003), we set the growth in capital flows equal to the growth in income, $\frac{df}{f} = \frac{dy}{y}$.

[58] Substituting the import and export demand functions in Equation 5.3 yields,
$\theta\left(p_d + (\eta\left(p_{d-e-p_f}\right) + \varepsilon z)\right) - \theta_1(p_d + r) + (1 - \theta + \theta_1)(f + P_d) = p_f + (\psi(p_f + e - p_d) + \pi y) + e.$

[59] This specification, $*\, y_{BSDART} = \frac{\theta x - \theta_1 r + (\psi + 1)(p_d - p_f - e)}{\pi - (1 - \theta + \theta_1)}$, does not include estimates from the export demand function, i.e. the income elasticity of demand or the price elasticity of demand for exports.

where y_{BSDAR}, is the balance of payments constrained growth rate with sustainable debt accumulation and interest payments abroad. If there are no interest payments, hence $\theta_1=0$, then Equation 5.6 becomes,

$$y_{BSDA} = \frac{\theta x}{\pi-(1-\theta)} \qquad \text{(Equation 5.7)}$$

where y_{BSDA}, is the balance of payments constrained growth rate with sustainable debt accumulation. If a country does not have a deficit then $\theta=1$, and Equation 5.7 reduces to the weak form of Thirlwall's original law,

$$y_B = x/\pi \qquad \text{(Equation 2.45)}$$

When comparing the different models of the balance of payments constrained growth rate we expect,

- Starting from balance of payments disequilibrium, the estimated growth rate from the model with sustainable debt accumulation given in Equation 5.7 is expected to be higher than the original model in Equation 2.45 if growth in real capital inflows are more than the growth in exports, (f>x). Likewise, if growth in real capital flows are less than the growth in exports, (f<x), the model with sustainable debt accumulation is expected to be lower than the original model[60].
- The terms of trade effect to be either negative or positive depending on the experience of the country in question.
- The balance of payments constraint growth model with sustainable debt accumulation and interest rate payments to be lower than the model that does not set a limit to capital inflows or account for interest rate payments abroad[61].

5.1.2.1. Economic Propositions

The higher the income elasticity of demand for imports π, the lower the balance of payments constrained growth rate. A faster growth rate of world income z, will raise the balance of payments constrained growth rate.

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[60] Starting from balance of payments disequilibrium, equal growth of exports and imports would widen the absolute gap that needed to be filled by capital inflows. If capital inflows do not grow at the same rate required to fill the gap, then income must adjust in order to keep the absolute gap between exports and imports equal to the growth in capital flows (Thirlwall and Hussain, 1982).

[61] We do not estimate the balance of payments constrained growth model with unlimited capital flows as it is not necessary to include this specification of the model in order to obtain the balance of payments constrained growth rate with sustainable debt accumulation. In addition there is a lack of comparable data across countries on capital flows.

Furthermore, the Marshall-Lerner condition is assumed to be true. That is, devaluations or a currency depreciation measured by the increase in the domestic price of foreign currency (e>0), will improve the balance of payments constrained growth rate provided that the absolute value of the sum of the price elasticity of demand for exports weighted by the proportion of the total import bill financed by export earnings and the price elasticity of demand for imports is greater than unity, i.e. $|\theta\eta + \psi| > 1$. However, even if the condition ($|\theta\eta + \psi| > 1$) is satisfied, a once off devaluation will not raise the balance of payments constrained growth rate permanently. After an initial devaluation, e, will fall back to zero and the growth rate will backslide to its former level (Thirlwall and Hussain, 1982).

5.1.3. Estimations

The estimation methodology is outlined below, this includes the unit root tests used to test the stationarity of the data, the Autoregressive Distributive Lag (ARDL) model and the bounds testing procedure used to test for cointegration.

5.1.3.1. Unit Root Tests and Structural Breaks

The sub-Saharan African countries have experienced several shocks over the last five decades. It is therefore necessary to account for structural breaks when testing the stationarity of the data. In this case the typical Augmented Dickey Fuller (ADF) test and the Phillips Perron (PP) test, whose null hypothesis is, there is a unit root may be invalid as the tests are biased towards the non-rejection of the hypothesis in the presence of a structural break, finding a unit root when it may actually not exist (Perron, 1989). In addition, Clemente et al (1998) have provided empirical evidence that it is erroneous to account for one structural break if in fact the series contains more breaks. Our preferred unit root test is therefore the Clemente, Montanes and Reyes (CMR) test which allows for two endogenously determined structural breaks. It is a modification of the Perron and Vogelsang (1992) unit root test which accounts for one break in the series. If evidence of only one structural break is found in the series then the Perron and Vogelsang test will be used. If there is no evidence of any structural break in the series then the traditional ADF and PP unit root tests will be used.

The CMR unit root test allows for two different types of structural breaks. Sudden changes in the series are captured by the Additive Outliers (AO) model while a gradual shift in the mean of the series is detected by the Innovational Outliers (IO) model (Baum, 2005). Both forms of structural change will be tested.

The null hypothesis is that the series has a unit root with a structural break while the alternative hypothesis is that the series is stationary with breaks. Prior knowledge of the structural break date or appropriate lag order is not needed as they are determined by a two dimensional grid search which looks for the lowest possible value for the t statistic from all the possible break points; allowing for the "strongest rejection" of the null hypothesis. A set of sequential F tests determines the lag order (Baum, 2005).

Endogenously determining the structural break is preferred to exogenously determining it as the latter is considered to be identified ex ante which is inappropriate as it invalidates the distribution theory underlying conventional testing (Christiano, 1992).

Structural breaks in the data will be addressed during estimation through the use of dummy variables. Including dummy variables to account for structural breaks is more efficient than splitting the sample, particularly when the sample size is relatively small (McCombie, 1997). Only significant dummy variables will be retained in the model.

5.1.3.2. Autoregressive Distributive Lag (ARDL) Model

The presence of structural breaks in the data creates uncertainty as to the stationarity of the variables. An ARDL model will therefore be used to estimate the import and export demand functions needed to calculate the balance of payments constrained growth rate. One advantage of the ARDL model is that it provides consistent estimates irrespective of whether the variables are integrated of order one (I(1)), or zero I(0) (Pesaran and Shin, 1998). The purpose of the unit root tests are to ensure that none of the series included are I(2), as this would invalidate the methodology.

The ARDL model is preferred to the Vector Autoregressive (VAR) model as it utilises a single equation estimation technique, making interpretation relatively simple. Another advantage when using the ARDL model is the lag order of the dependent and independent variables are allowed to vary without affecting the asymptotic result.

In addition, it is possible to test for cointegration using the bounds testing procedure. Other cointegration tests such as the Johansen system-based reduced rank regression approach or the Engle-Granger two step residual-based procedure, are restricted to only I(1) variables. Pesaran and Shin (1998), further show that the bounds cointegration test is superior to the Johansen cointegration test in small samples.

A general ARDL(p,q) is outlined below,

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{p} \emptyset_i y_{t-i} + \beta' x_t + \sum_{i=0}^{q-1} \beta_i^{*\prime} \Delta x_{t-i} + u_t$$

$$\Delta x_t = P_1 \Delta x_{t-1} + P_2 \Delta x_{t-2} + \cdots + P_s \Delta x_{t-s} + \varepsilon_t \quad \text{(Equation 5.8)}$$

Here the underlying variables are I(1) however the model provides consistent results even when modified to include a mixture of I(1) and I(0) variables or just I(0) variables. The dependent variable y_t, is regressed on its lagged values y_{t-1}, a set of dependent I(1) x_t, variables that are not cointegrated amongst themselves, and the differenced lagged variables of x_t. U_t, and ε_t, are serially uncorrelated disturbances with the usual mean of 0 and constant variance and covariance. Correlation between u_t, and ε_t, can be overcome by including an adequate number of lagged changes in the regressors. P_i, are the k x k coefficient matrices so that the vector autoregressive process in Δx_t, is stable[62]. Two additional assumptions are made, that the roots of, $1 - \sum_{i-1}^{p} \emptyset_i z^i = 0$, all fall outside the unit circle and a long run stable relationship exists between y_t, and x_t (Pesaran and Shin, 1998) [63].

The contemporaneous dependence between u_t, and ε_t, is explicitly modelled in order to derive the short run effects. Pesaran and Shin (1998) have shown that the ARDL approach to estimation and inference is asymptotically valid.

The ARDL model outlined above can be reparametrized in the form of an Error Correction (EC) model (Hassler and Wolters, 2005),

$$\Delta y_t = c_0 + c_1 t + \gamma y_{t-1} + \vartheta' x_{t-1} + \sum_{i=1}^{p-1} a_i \Delta y_{t-i} + \sum_{i=0}^{n-1} \beta_i' \Delta x_{t-i} + u_t \quad \text{(Equation 5.9)}$$

Where, $\gamma = -a(1)$, $\vartheta = a(1)\beta = -\gamma\beta$.

The above model contains both an intercept and trend however it can be expressed as having just an intercept or neither an intercept or trend.

When using the ARDL model, selecting the right lag order is important for valid inferences. The appropriate lag order will be selected using the Schwarz Bayesian Criterion (SBC) as according to Pesaran and Shin (1998), the ARDL model using the SBC performed slightly better than the ARDL model using the Akaike Information Criterion (AIC). This may be because SBC is a consistent model selection criterion while the AIC is not.

The usual normality tests will be carried out to ensure appropriate model selection. This includes the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity and the Breusch-Godfrey test for

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[62] X_t is the k-dimensional I(1) variable.
[63] Under this assumption, the elements of z_t, are allowed to be purely I(1), purely I(0) or cointegrated. The possibility of seasonal unit roots and explosive roots are excluded (Pesaran et al, 2001).

serial correlation. The stability of the model over time is tested by calculating and graphing the Cumulative Sums (CUSUM) as well as the CUSUM squared of the recursive residuals from the variables defined in the model and their respective 95% confidence bands.

Following the selection of the appropriate ARDL model, the long run parameters and valid standard errors need to be obtained[64]. The latter will be estimated using the Ordinary Least Squares (OLS) delta method (Δ-method)[65]. This approach is directly comparable to the fully modified OLS approach of Phillips and Hansen (1990)[66], however Pesaran and Shin (1998) have provided some evidence that the delta method outperforms the latter in small samples. Additionally, the delta method results are asymptotically valid irrespective of whether x_t, is I(1) or I(0).

The static formulation of the cointegrating regression can be expressed as,

$$y_t = \mu + \delta t + \theta' x_t + v_t$$
$$\Delta x_t = e_t \qquad \text{(Equation 5.10)}$$

where δ, and θ, are the long run parameters defined in the level ARDL model in Equation 5.8, by the ratio $\delta = \alpha_1/\emptyset(1)$, and $\theta = \beta/\emptyset(1)$, where $\emptyset(1) = 1 - \sum_{i=1}^{p} \emptyset_i$. From the error correction or first differenced ARDL model in Equation 5.9, the long run parameters δ, and θ, are defined as, $\delta = -c_1/\gamma$, and, $\theta = -\vartheta/\gamma$. The long run parameters estimated from the level form and the first difference form are identical (Hassler and Wolters, 2005). We therefore make use of the conditional error correction ARDL model as the existence of a single long run level relationship between the levels of y_t, and x_t, can easily be tested using the bounds testing procedure.

From the estimated error correction model in Equation 5.9, we can use the Wald or F statistic to test the joint hypothesis that there is no level relationship between the level variables y_t, and x_t, i.e. H_0: $\gamma=0$ and $\vartheta=0$. Pesaran et al (2001) provide two sets of critical value bounds covering all possible classifications of the forcing variable $\{x_t\}$, into I(0) which provides the lower bound, I(1) related to the upper bound and mutually integrated process[67]. A conclusive decision regarding

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[64] The ARDL long run variance is defined as, $\sigma_\eta^2/[\phi(1)]^2$.

[65] The Bewley's (1979) regression approach is an alternative method for estimating the long run parameters from the selected ARDL model. It provides identical results to the OLS delta method (Pesaran and Shin, 1998). Preference is based on computational convenience.

[66] Problem with the OLS estimator: the unit root distribution and second order bias arising from the contemporaneous correlation, which may exist between v_t, and e_t, is generally involved in the asymptotic distribution of the OLS estimator of the long run parameter θ. As inferences on θ using the t-tests in the OLS regression are therefore invalid, Phillips and Hansen (1990) suggest the adoption of a fully-modified OLS procedure. Both the fully-modified OLS procedure and the ARDL based are asymptotically valid. Preference between the two is based in computational convenience (Pesaran and Shin, 1998).

[67] The asymptotic critical values are obtained through simulation for when, $r = k$ and $\{x_t\}\sim(1)$ and also for when $r = 0$ and $\{x_t\}\sim(1)$. R, the cointegration rank of the forcing variables $\{x_t\}$ follows the process $0 \leq r \leq k$ (Pesaran et al, 2001).

cointegration of the variables can be made when the computed F statistic falls outside the critical value bounds. If the computed F statistic is greater than the upper bound critical value, then the null hypothesis of no single long run relationship between the variables is rejected. If the computed Wald or F statistic is below the lower bound critical value, we accept the null hypothesis of no long run level relationship between the variables. If however the computed Wald or F statistic falls within the bounds, inference would be inconclusive and the rank, r, of the forcing variables $\{x_t\}$, would need to be determined in order to proceed.

In the absence of cointegration, we take the first difference of the variables and estimate the import and export demand function using OLS.

Estimating the import and export demand functions

We estimate the import and export demand functions needed to derive the balance of payments constrained growth rate. The import demand function, estimated using the ARDL model is,

$$\Delta In\_M_t = c_0 + \gamma In\_M_{t-1} + \vartheta In\_Y_{t-1} + \varpi In\_iREER_{t-1} + \sum_{i=1}^{p-1} a_i \Delta In\_M_{t-i} + \sum_{i=0}^{n-1} \beta_i' \, \Delta In\_Y_{t-i} + \sum_{i=0}^{n-1} \zeta_i' \, \Delta In\_iREER_{t-i} + u_t \qquad \text{(Equation 5.11)}$$

where the first differenced imports, ΔIn_M_t, are regressed on their lagged and lagged differenced values. Included are the lagged values and the lagged differenced values of domestic income, In_Y and the real effective exchange rate measured as the domestic price for foreign currency, In_iREER. We expect the long run coefficient for domestic income to be positive, i.e. >0 and the long run coefficient for the real effective exchange rate to be negative, i.e. <0.

The export demand function is given by,

$$\Delta In\_X_t = c_0 + \gamma In\_X_{t-1} + \vartheta In\_ZY_{t-1} + \varpi In\_REER_{t-1} + \sum_{i=1}^{p-1} a_i \Delta In\_X_{t-i} + \sum_{i=0}^{n-1} \beta_i' \, \Delta In\_ZY_{t-i} + \sum_{i=0}^{n-1} \xi_i' \, \Delta In\_REER_{t-i} + u_t \qquad \text{(Equation 5.12)}$$

where first differenced exports, ΔIn_X_t, are regressed on their lagged and lagged differenced values, lagged and lagged differenced values of world income, In_ZY and the real effective exchange rate measured as the foreign price for domestic currency, In_REER. We expect the long run coefficient for world income to be positive, i.e. >0 and the long run coefficient for In_REER to be negative, i.e. <0.

5.1.3.3. Testing the Balance of Payments Constrained Growth Model

Several procedures have been proposed for testing the equivalence of the balance of payments constrained growth rate to the actual growth rate of a country[68]. An informal method is to look at the estimated export demand function. If the income elasticity of demand for exports, $\hat{\varepsilon}$, is statistically significant and the coefficient on the relative price index, $\hat{\eta}$, is small and insignificant, we cannot refute the balance of payments constrained growth model (Britto and McCombie, 2009).

We make use of three formal approaches. The first approach allows us to formally test the balance of payments constrained growth model for an individual country while the second and third approach allows us to test the model for a group of countries. For the first approach, we make use of the method proposed by McCombie (1989) which is to calculate the hypothetical income elasticity of demand which exactly equates the actual rate of growth using the balance of payments constrained model. We then test if it is equal to the estimated income elasticity of demand from the import demand function using the Wald test. Failing to reject the null hypothesis for the equivalence between the two elasticities of demand would provide evidence in favour of the balance of payments constrained growth rate.

Due to variations in the export to import ratio, θ, and the interest payment to import ratio, θ_1, we calculate the hypothetical growth rate using both the start value at the beginning of the period concerned and the average value for the period (Britto and McCombie, 2009). The hypothetical income elasticities that would equate the actual rate of growth given by the balance of payments constrained growth model are shown in Table 5.1.

[68] For a full outline of all the different methods proposed see McCombie (1997).

Table 5.1; Hypothetical income elasticity of demand for imports, π_H (Moreno-Brid, 2003)

Balance of payments constrained growth model	Solving for the income elasticity of demand
$* \, y_{BSDART} = \frac{\theta \epsilon z - \theta_1 r + (\theta\eta + \psi + 1)(p_d - p_f - e)}{\pi - (1 - \theta + \theta_1)}$	$* \, \pi_{HBSDART} = (1 - \theta + \theta_1) + \frac{\theta \epsilon z - \theta_1 r + (\theta\eta + \psi + 1)(p_d - p_f - e)}{y}$
$y_{BSDART} = \frac{\theta x - \theta_1 r + (\psi + 1)(p_d - p_f - e)}{\pi - (1 - \theta + \theta_1)}$	$\pi_{HBSADRT} = (1 - \theta + \theta_1) + \frac{\theta x - \theta_1 r + (\psi + 1)(p_d - p_f - e)}{y}$
$y_{BSDAR} = \frac{\theta x - \theta_1 r}{\pi - (1 - \theta + \theta_1)}$	$\pi_{HBSDAR} = (1 - \theta + \theta_1) + \frac{\theta x - \theta_1 r}{y}$
$y_{BSDA} = \frac{\theta x}{\pi - (1 - \theta)}$	$\pi_{HBSDA} = (1 - \theta) + \frac{\theta x}{y}$
$y_B = \frac{x}{\pi}$	$\pi_{HB} = \frac{x}{y}$

Note: $* \, y_{BSDART}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports

y_{BSDART}, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade (only the income and price elasticities from the import demand function are included)

y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad

y_{BSDA}, is the balance of payments constrained growth with sustainable debt accumulation

y_B, is the “weak” original version of the balance of payments constrained growth model

Our second approach was first proposed by McGregor and Swales (1985) and later modified by McCombie (1997), makes use of pooled data for all the countries. McGregor and Swales (1985) regress the actual rate of growth on the balance of payments constrained growth and test the hypothesis that the intercept and slope coefficient are not statistically different from 0 and 1 respectively. As pointed out by McCombie (1997, p.347), the above regression suffers from a, "misspecification analogous to an error in variables problem," as the balance of payments constrained growth rates are stochastic as they were derived from prior estimation coefficients which have associated standard errors. A simple way to overcome this is to regress the balance of payments constrained growth rate on the actual growth rate[69]. The modified method proposed by McCombie (1997) will be applied. One of the limitations of this approach is that the countries which persistently run a balance of payments surplus must be excluded from the regression. According to McCombie (1997), this does not invalidate the balance of payments constrained model as not all countries can be balance of payments constrained. In this case, we are testing that the sub-Saharan African countries are balance of payments constrained.

The third method applies panel Granger causality tests to determine if causality runs from the balance of payments constrained growth to actual growth or vice versa. Evidence of the former provides support that growth is balance of payments constrained. We estimate the model which best fits the growth process in the region for each year and carry out panel Granger causality tests. This overcomes one of the limitations in the first method as the share of exports and interest payments in total receipts are not constant over time. The estimates obtained will unfortunately suffer from the error in variables problem. This is to some extent overcome by using the growth in exports as a proxy for the balance of payments constrained growth. This is appropriate as in the original "weak" version of the model, the balance of payments constrained growth is equal to the growth in exports divided by the income elasticity of demand for imports, which is constant (Lanzafame, 2014). Additional Granger causality tests are therefore carried out on the growth in exports and the growth in income. We use annual data, as well as a 5 year non overlapping average to smooth out short term fluctuations. In order to avoid problems related to spurious regressions, we carry out Maddala and Wu (MW) panel unit root tests. We then make use of the panel VAR model within a Generalised Method of Moments (GMM) framework (Abrigo and Love, 2015). Please see section 6.2 for a detailed outline of the estimation model.

[69] The decision to regress the balance of payments constrained growth on the actual rate of growth does not indicate causality (McCombie, 1997).

5.2. Results

The results obtained from the unit root tests, the estimated import and export demand functions using the ARDL model and the estimates for the balance of payments constrained growth model are presented in this section.

5.2.1. Unit Root Tests

The results from the unit root tests can be seen in Appendix G. All the variables were either I(0) or I(1) as determined by the ADF test, the PP test, the Perron and Vogelsang test and the CMR test. The appropriate unit root test was chosen based on the presence of no structural break, one structural break or two structural breaks respectively. As all the variables are either I(0) or I(1) we proceed with the ARDL model to estimate the import and export demand functions.

5.2.2. Import Demand Function

The import demand function is estimated for 22 sub-Saharan African countries. A summary of the results derived using the ARDL model can be seen in Table 5.2. Only the long run estimates for the income elasticity of demand and the price elasticity of demand for imports along with some of the diagnostic tests are reported. Appendix H contains more detailed results, including the short run estimates. Appendix P contains the CUSUM and CUSUM squared graphs which test the stability of the model.

For 13 countries, the price elasticity of demand for imports was small and insignificant, ranging from -1.494 for Kenya to -0.121 for Uganda, highlighting the small role relative prices have played in the region. The income elasticity of demand for imports was significant for 20 countries. For Zambia, the income elasticity of demand for imports was 4.562 which is relatively high as the income elasticity of demand for imports for the rest of the 19 countries ranged from 0.475 for Gambia to 2.310 for Sierra Leone. This provides evidence in favour of the balance of payments constrained growth model as it shows that relative prices play a very small or no role in the import demand function. What is of importance is the income elasticity of demand for imports which is determined by a countries economic structure.

For the Democratic Republic of Congo, Gabon, Mali, Sierra Leone, Sudan and Uganda we do not find any evidence against the null hypothesis of no cointegration between the variables using the bounds testing procedure. We therefore take the first difference of the variables and re-estimate the import demand function using OLS. We follow the same procedure for Togo as we could not estimate a stable import demand function using the ARDL model. The results are in Table 5.3.

Table 5.2; Summary of the long run estimates from the import demand function estimated using the ARDL model

Country	Income elasticity of demand for imports, π		Price elasticity of demand for imports, ψ		ARDL	SBC	R^2	Bounds F test	Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (P value)	Breusch-Godfrey test for serial correlation (P value)
Benin	1.142***	(0.109)	-1.08***	(0.242)	(1 1 1)	-74.481	0.795	10.289***	0.997	0.508
Botswana	0.896***	(0.023)	-0.53***	(0.168)	(3 1 0)	-67.41	0.756	10.200***	0.471	0.744
Cameroon	1.379***	(0.087)	0.657***	(0.177)	(1 0 0)	-63.204	0.403	5.775**	0.639	0.664
Chad	0.659***	(0.157)	-0.278*	(0.152)	(2 0 0)	-21.17	0.852	20.472***	0.163	0.681
Congo, Dem. Rep.[70]	2.179*	(1.266)	-0.278	(0.546)	(2 1 1)	-12.424[AIC]	0.568	3.754	0.772	0.193
Congo, Rep.	1.483***	(0.291)	-1.036	(0.627)	(3 3 3)	-57.642	0.968	4.221*	0.493	0.293
Gabon	1.275***	(0.155)	-0.85***	(0.226)	(1 1 0)	-57.804	0.659	3.182	0.257	0.751
Gambia	0.475**	(0.193)	-0.25	(0.243)	(2 1 1)	-63.965[AIC]	0.44	4.212*	0.67	0.346
Kenya	0.986***	(0.212)	-1.494***	(0.354)	(1 0 0)	-58.354	0.272	3.892*	0.119	0.644
Mali	2.195**	(1.07)	-0.64	(2.089)	(1 1 1)	-35.912	0.179	0.716	0.136	0.156
Mauritius	1.183***	(0.165)	-1.131	(1.537)	(1 2 4)	-83.903	0.86	5.404**	0.893	0.095*
Mozambique	1.877***	(0.451)	-0.168**	(0.064)	(1 2 1)	-50.439	0.696	9.674***	0.535	0.562
Namibia	1.946***	(0.184)	-0.148	(0.615)	(1 2 2)	-64.769	0.786	5.280**	0.829	0.817
Nigeria	0.941***	(0.299)	-0.148	(0.109)	(1 3 1)	-6.661	0.872	9.114***	0.238	0.135
Senegal	1.107***	(0.081)	-0.126	(0.126)	(1 0 0)	-97.159	0.491	6.911***	0.515	0.452
Sierra Leone	2.310**	(0.977)	0.68	(0.802)	(1 1 1)	-3.750[AIC]	0.363	2.87	0.039**	0.843
South Africa[71]	0.819	(0.59)	-1.064	(0.399)	(1 1 0)	-131.366	0.803	10.590***	0.776	0.263
Sudan	0.957***	(0.197)	0.177	(0.309)	(1 0 0)	-1.585	0.147	2.657	0.743	0.802
Uganda	1.553***	(0.236)	-0.121	(0.157)	(4 4 3)	-83.982	0.953	2.751	0.435	0.886
Zambia	4.562*	(2.169)	-0.267	(0.199)	(1 4 5)	-18.215	0.841	4.912**	0.364	0.953
Zimbabwe	1.167***	(0.237)	-0.281*	(0.146)	(1 0 1)	-19.28	0.695	9.487***	0.008***	0.938

Note: [AIC] indicates that the model was selected using the AIC criterion due to the persistence of autocorrelation when using the model selected by SBC
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

[70] For the Democratic Republic of Congo we control for the ongoing civil war which started in 1997 till present.
[71] A trend is added for South Africa. We control for apartheid which made very little difference to the outcome. The results can be seen in Appendix J.

Table 5.3; Summary of results for the import demand function estimated using OLS

Country	Income elasticity of demand for imports, π		Price elasticity of demand for imports, ψ		R^2	Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (P value)	Breusch-Godfrey test for serial correlation (P value)
Congo, Dem.Rep.	2.372***	(0.605)	-0.053	(0.127)	0.247	0.805	0.524
Gabon[robust]	0.979***	(0.284)	-0.178	(0.221)	0.579		
Mali	0.049	(0.374)	-0.099	(0.169)	0.352	0.314	0.197
Togo[robust]	1.608***	(0.495)	-0.834***	(0.203)	0.217		
Uganda[robust]	2.061***	(0.613)	-0.225***	(0.059)	0.557		
Sierra Leone	0.775	(0.501)	0.416*	(0.216)	0.173	0.323	0.675
Sudan	0.963	(0.562)	-0.095	(0.094)	0.070	0.172	0.392

Note: Standard errors are in parenthesis
[robust] are heteroscedasticity consistent standard errors
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

The income elasticity of demand using OLS for the Democratic Republic of Congo, Gabon, Uganda and Sudan were close to that estimated using the ARDL model as there was less than a 0.5 point difference. We therefore proceed to estimate the balance of payments constrained growth using both the estimates obtained from the ARDL model as well as OLS for the above mentioned countries.

The income elasticity of demand for imports using OLS ranged from 0.963 for Sudan to 2.372 for the Democratic Republic of Congo. The price elasticity of demand for imports ranged from -0.834 for Togo to -0.05 for the Democratic Republic of Congo.

It was not possible to estimate reasonable import demand functions using OLS for Mali and Sierra Leone as the income elasticity of demand for imports was insignificant at the 10% level. The price elasticity of demand for imports for Mali was insignificant and had the wrong sign for Sierra Leone. We therefore proceed with the results obtained from the ARDL model for these two countries although caution is needed when making inferences.

5.2.2.1. Comparing the Estimated Income Elasticity of Demand with Other Studies

Due to the importance of the income elasticity of demand for calculating the balance of payments constrained growth rate, we compare our estimates with those from other studies. According to McCombie (1997), the income elasticity of demand for imports is stable over time as it represents non price based competition which changes very slowly. It is therefore still informative to compare our results with those from other studies in the region despite the time frame covered being different. The comparison can be seen in Table 5.4. Our estimates appear reasonable as they are close to those estimated in other studies. The income elasticity of demand ranged from 0.34 to 5.0 in other studies (Senhadji, 1998; Hussain, 1999; Perraton, 2003) while it ranged from 0.475 to 4.562 in our analysis.

Table 5.4; Comparison of the estimated income elastictity of demand with other studies

Country	Our Estimates	Senhadji (1998)	Hussain (1999)	Perraton (2003)
Benin	1.142	4.91	1.97	
Botswana	0.896			
Cameroon	1.379	1.01	0.84	0.88
Chad	0.656			
Congo Dem. Rep.	2.179			
Congo Rep.	1.483	0.87	1.44	
Gabon	1.275		1.37	
Gabon (OLS)	0.979			
Kenya	1.06	1.14	0.98	1.84
Gambia	0.475	1.51		
Mali	2.195			0.87
Mauritius	1.183	2.25	1.23	1.17
Mozambique	1.877			
Namibia	1.946			
Nigeria	0.941	1.81	2.70	
Senegal	1.107		2.26	0.98
Sierra Leone	2.310		1.54	
South Africa	0.955	0.67	1.38	
Sudan	0.957		1.57	
Togo	1.608		1.93	5.00
Uganda	1.553			
Uganda (OLS)	2.061			
Zambia	4.562	0.34	1.11	
Zimbabwe	1.167		1.64	

Note: OLS indicates the income elasticity of demand from the import demand function using OLS

5.2.3. Export Demand Function

A summary of the results for the export demand function can be seen in Table 5.5. Only the long run estimates and the results from the diagnostic tests are shown. For full details of the results including the short run coefficients please see Appendix I.

We were able to estimate the export demand function for 19 countries using the ARDL model. The income elasticity of demand for exports ranged from 0.606 for Senegal to 3.446 for Uganda however it was much higher for Mozambique at 4.786, Zambia at 8.041 and Zimbabwe at 14.607. The price elasticity of demand for exports was less than zero in absolute terms for 12 countries. It was insignificant for 14 countries. For the 5 countries where the price elasticity of demand for exports was significant at the 5% level, it stood at, -1.577 for Botswana, -0.605 for the Republic of Congo, -0.860 for Mali, -6.865 for Sudan and -1.390 for Zimbabwe. These results provide further support for the balance of payments constrained growth model.

For Kenya, Benin, Cameroon, Democratic Republic of Congo, Chad, and Mauritius we fail to find any evidence of cointegration using the bounds testing procedure. For Gabon, we could not estimate a stable export demand function with the ARDL model and therefore proceed with OLS, making the necessary adjustments to account for the non-stationarity of the variables.

The OLS results are given in Table 5.6. It was possible to estimate the export demand function for the Democratic Republic of Congo and Gabon.

Table 5.5; Summary of the long run estimates from the export demand function estimated using the ARDL model

Country	Income elasticity of demand for exports, ε		Price elasticity of demand for exports, η		ARDL	SBC	R^2	Bounds F test	Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (P value)	Breusch-Godfrey test for serial correlation (P value)
Benin[72]	2.673***	(0.54)	0.058	(0.455)	(6 7 6)	13.046	0.591	1.927	0.811	0.223
Botswana	1.937***	(0.188)	-1.577**	(0.689)	(1 1 0)	-48.83	0.621	3.465	0.225	0.212
Cameroon	1.348***	(0.379)	-0.496	(0.749)	(1 1 0)	-51.295	0.574	2.555	0.373	0.75
Chad	2.469**	(0.968)	1.261	(0.896)	(1 2 0)	22.52	0.483	2.26	0.045**	0.181
Congo, Dem. Rep.	2.83	(1.098)	0.74	(0.648)	(1 1 1)	-9.155	0.407	3.724	0.424	0.278
Congo, Rep.	1.018***	(0.113)	-0.605***	(0.125)	(1 2 0)	-98.318	0.65	6.615***	0.892	0.158
Gambia	1.198***	(0.247)	0.873	(0.259)	(2 1 1)	-63.188[AIC]	0.658	7.447***	0.282	0.249
Kenya	1.218***	(0.372)	-0.425	(1.123)	(1 0 1)	-103.528	0.197	0.622	0.662	0.162
Mali	1.851***	(0.248)	-0.860***	(0.279)	(1 0 4)	-62.539	0.745	8.413***	0.852	0.57
Mauritius	1.581***	(0.418)	-0.816	(1.652)	(1 1 1)	-81.53	0.489	0.575	0.034**	0.203
Mozambique	4.786***	(0.44)	-0.45	(0.423)	(1 0 0)	-50.477	0.665	9.997***	0.239	0.283
Namibia	1.299***	(0.052)	0.187	(0.136)	(2 2 2)	-68.298	0.753	13.251***	0.975	0.274
Nigeria	1.668***	(0.263)	0.035	(0.119)	(1 0 0)	1.534	0.389	4.366*	0.456	0.347
Senegal	0.606***	(0.089)	-0.099	(0.128)	(1 3 0)	-61.174	0.717	16.575***	0.040**	0.515
South Africa	1.637**	(0.629)	0.268	(0.839)	(1 1 1)	-175.118	0.598	6.253**	0.095*	0.234
Sudan	0.719	(0.503)	-6.865**	(2.868)	(2 0 3)	-22.575	0.565	13.214***	0.018**	0.598
Uganda	3.466***	(0.586)	-0.011	(0.287)	(1 1 1)	-16.188	0.43	4.599*	0.95	0.201
Zambia	8.041**	(3.557)	-10.155	(7.02)	(2 2 2)	-25.404	0.809	11.132***	0.152	0.599
Zimbabwe	14.607***	(3.615)	-1.390***	(0.278)	(4 1 4)	-36.537	0.806	8.502***	0.074*	0.331

Note: [AIC] indicates that the model was selected using the AIC criterion due to the persistence of autocorrelation when using the model selected by SBC
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

[72] The export demand function for Benin is from 1974-2015 due to data availability.

Table 5.6; Summary of results for the export demand function estimated using OLS

Country	Income elasticity of demand for imports, π		Price elasticity of demand for imports, ψ		R^2	Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (P value)	Breusch-Godfrey test for serial correlation (P value)
Congo, Dem. Rep.	3.972**	(1.793)	-0.066	(0.111)	0.135	0.389	0.522
Gabon	1.781	(0.988)	-0.071	(0.201)	0.145	0.838	0.908

Note: Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

5.2.4. Reliability of the Results: Import and Export Demand Functions

We endogenously test for structural breaks in the data using the Clemente, Montanes and Reyes (CMR) and the Perron and Vogelsang (1992) test. Where significant, we include a dummy variable in the estimated model, which is preferred to splitting the sample due to the relatively limited sample size (McCombie, 1997). The bias in the estimated coefficients arising from the structural breaks is therefore eliminated.

Different significant breaks in the data were found for the respective countries. When estimating the balance of payments constrained growth model in section 5.2.5, we use the entire sample period however when analysing sub-periods, we focus on the 1960 to 1980 period and the 1980 to 2014 period. Trade liberalisation policies were mainly implemented during the early 1980's period in many African countries. This change in policy from import substitution industrialisation is likely to have affected the balance of payments constrained growth rate. Choosing the same break point allows us to directly compare the balance of payments constrained growth rate for the countries included in the analysis.

The Marshall-Lerner condition states that devaluation could improve the balance of payments position if the absolute value of the sum of the price elasticity of demand for exports weighted by the proportion of the total import bill financed by export earnings and the price elasticity of demand for imports is greater than unity, i.e. $|\theta\eta+\psi|>1$. This condition is met for five out of the 22 countries included in the analysis. These were Benin, Botswana, Kenya, Sudan and Zimbabwe. This finding, that the elasticity conditions are generally not met in developing countries is in line with the work carried out by Hussain (1995). It provides further support for the balance of payments constrained growth model as it is non-price based factors that determine the relative competitiveness of respective countries.

5.2.5. The Estimated Balance of Payments Constrained Growth Rate

The estimates for the income and price elasticities of demand from the import and export demand functions are applied to calculate the balance of payments constrained growth rates given in Equations 5.4 to 5.7 and 2.44 to 2.45. These can be seen in Table 5.7 and include the original weak version of Thirlwall's law, y_B, the strong version of Thirlwall's law, $*y_B$, the balance of payments constrained growth rate with sustainable debt accumulation, y_{BSDA}, the balance of payments constrained growth with sustainable debt accumulation and interest rate payments abroad, y_{BSDAR}, and finally the two versions of the balance of payments constrained growth with sustainable debt accumulation, interest rate payments abroad and the terms of trade. In the former version the terms of trade are interacted with the price elasticities of demand for exports and imports, $*y_{BSDART}$, and in the latter the terms of trade are only interacted with the price elasticity of demand for imports, y_{BSDART}.

The stability condition for sustainable debt accumulation (Barbosa-Filho, 2001), as given in Equation 5.4 to 5.7 is met for the majority of countries as the income elasticity of demand for imports is equal to or more than 1. For countries like Gabon, Nigeria, South Africa and Sudan where the income elasticity of demand was between 0.941 and 0.979, we are unable to reject the null hypothesis using the Wald test that the income elasticity of demand is equal to 1 as indicated in Table 5.8. The condition however is not met for Gambia, Chad and Botswana.

The different balance of payments constrained growth rates are estimated for the entire sample period which ranges from around the 1960s to 2014 period. This can be seen in Table 5.7 where the estimated balance of payments constrained growth rates are compared with the actual growth rate for the period concerned. We also estimate the balance of payments constrained growth rate for the sub-periods 1960 to 1980 and 1980 to 2014 which can be seen in Appendix K.

The balance of payments constrained growth model does a very good job at predicting the actual growth rate for the region. The absolute difference between the actual growth rate and the balance of payments constrained growth rate was less than 0.5 for 17 out of 22 countries and less than one for 19 countries. The simple model best explained the growth process for South Africa, Mali, Uganda and Zimbabwe as the absolute difference between the balance of payments constrained growth rate and the actual growth rate was 0.18, 0.04, 0.84 and 0.06 respectively. The strong version of the model best explained the growth process for Kenya where the difference was 0.42 while the model which allows for sustainable debt accumulation best predicted the growth rate for Cameroon with an absolute error of 0.11.

The model with the most predictive power was the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad. The model closely predicted the growth rates of the Democratic Republic of Congo, Sudan, Mauritius, Senegal, Sierra Leone and Togo with an absolute error of 0.02, 0.15, 0.04, 0.17, 0.01 and 0.17 respectively. This was closely followed by the balance of payments constrained growth which includes the terms of trade interacted with the price elasticities of demand for imports and exports, which closely predicted the growth rates of Nigeria, Botswana, Republic of Congo, Gabon, Mozambique and Zambia with an error of 0.13, 0.98, 0.37, 0.04, 0.02 and 0.58 respectively.

Finally the balance of payments constrained growth rate which included the terms of trade and only the price elasticity of demand for imports best predicted the growth rate of Gambia with a difference of 0.27.

The model failed to make a reasonable prediction for the actual growth rate for three countries. These are Namibia, Benin and Chad where the absolute difference between the actual and predicted growth rate was 1.59, 2.11 and 10.91 respectively.

For 90% of the countries included in the analysis, the theoretical expectation was met that the balance of payments constrained growth rate with sustainable debt accumulation would be lower than the original weak version of Thirlwall's law if, the growth in real capital flows was less than the growth in real exports (f<x), the difference indiscernible if real capital flows are equal to the growth in real exports (f=x) and higher if real capital flows are more than the growth in real exports (f>x).

Table 5.7; The balance of payments constrained growth rate estimated for the 1960 to 2014 period

					Start^{N}				Average^{N}				
Period	Country	Actual	y_B	$* y_B$	y_{BSDA}	y_{BSDAR}	$* y_{BSDART}$	y_{BSDART}	y_{BSDA}	y_{BSDAR}	$* y_{BSDART}$	y_{BSDART}	x
1975-2014	Benin	3.680	7.197	8.281	6.453	5.830	7.0800	6.066	5.880	5.788	6.981	6.090	8.219
1975-2014	Botswana	7.535	9.284	6.552	9.101	9.095	6.158	9.166	9.654	9.657	6.555	9.780	8.319
1960-2014	Cameroon	3.647	3.530		3.535	3.371	-0.461	3.314	3.514	3.405	-0.184	3.405	4.869
1960-2005	Chad	3.617	14.524		80.780	85.006	-27.788	58.628	67.030	67.866	-20.615	47.611	9.528
1960-2014	Congo, Dem. Rep.	1.348	3.030	4.597	3.472	1.438	3.255	1.357	4.523	4.035	6.356	3.983	6.603
1960-2014	Congo Dem. Rep.[73] (OLS)	1.348	2.783	5.927	3.222	1.329	5.085	1.254	4.302	3.834	8.709	3.785	6.603
1960-2014	Congo, Rep.	4.501	5.082	2.428	5.953	5.326	2.128	4.867	3.418	3.001	0.287	1.831	7.537
1960-2014	Gabon	4.47	4.087		4.607	4.162		4.116	4.624	4.460		4.416	5.211
1960-2014	Gabon (OLS)[74]	4.47	5.322	6.436	5.263	4.776	5.572	4.430	5.261	5.083	5.871	4.755	5.211
1966-2013	Gambia	3.977	8.770	8.330	66.656	107.126	-127.012	-44.516	-13.443	-13.358	10.352	3.707	4.166
1960-2014	Kenya	4.789	4.161	4.369	4.167	3.969	3.906	3.621	4.180	4.137	4.034	3.807	4.103
1967-2007	Mali	3.731	3.683	2.953	2.271	2.099	1.674	2.152	1.699	1.639	1.343	1.697	8.085
1976-2014	Mauritius	4.581	4.872	3.975	4.809	4.617	3.924	4.831	4.558	4.512	3.934	4.778	5.764
1980-2014	Mozambique	5.044	4.907	7.399	3.035	2.644	5.021	3.452	1.668	1.625	3.444	2.595	9.211
1980-2014	Namibia	3.531	1.626	1.937	1.558		1.551	1.254	1.676		1.687	1.370	3.165
1980-2013	Nigeria	4.279	5.566	5.211	5.378	3.489	4.409	4.786	5.747	4.626	8.760	9.149	5.238
1960-2014	Senegal	2.829	3.107	1.936	2.996	2.543	0.446	1.630	3.027	2.975	1.014	2.161	3.44
1967-2014	Sierra Leone	3.137	3.811		3.150	2.240		2.650	3.382	3.242		3.624	8.805
1960-2014	South Africa	3.239	3.058	6.068	3.035	2.851	6.002	2.914	3.014	2.888	5.974	2.939	2.921
1960-2014	Sudan	3.934	5.900	2.658	5.901	3.813	-31.232	9.220	5.874	3.346	-32.290	8.212	5.647
1960-2014	Sudan (OLS)	3.934	5.864		5.864	3.789		9.161	5.841	3.324		8.164	5.647
1960-2014	Togo	3.934	5.243		4.201	3.761		3.692	3.279	3.142		3.058	8.431
1982-2014	Uganda	6.089	6.960	6.717	4.826	4.912	1.067	1.240	4.055	4.191	-0.251	-0.099	10.81
1982-2014	Uganda (OLS)	6.089	5.245		3.199	3.222		1.356	2.576	2.599		0.536	10.81
1960-2013	Zambia	3.389	2.007	6.271	1.607	-0.634	3.965	0.05	1.369	0.865	4.507	1.506	9.159
1976-2014	Zimbabwe	1.586	1.528	37.24	1.469	0.319	35.494	1.390	1.502	1.476	35.947	2.396	1.784

[73] For the Democratic Republic of Congo both the import and export demand function use OLS.
[74] For Gabon both the import and export demand function use OLS.

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered

$y_{B,}$ is the "weak" original version of the balance of payments constrained growth model

$y_{B,}$ is the "strong" original version of the balance of payments constrained growth model

$y_{BSDA,}$ is the balance of payments constrained growth with sustainable debt accumulation

y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad

$* \; y_{BSDART}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports

y_{BSDART}, is the balance of payments constrained growth with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)

x is growth in real exports.

OLS indicates the growth rates that have been estimated using the import and export demand functions derived from OLS

5.2.6. Formally Testing the Balance of Payments Constrained Growth Model

We were able to estimate the balance of payments constrained growth rate for 22 countries. We begin by formally testing the model for each individual country. A summary of the results can be seen in Table 5.8. For 18 countries, which is almost 82% of the countries included in the analysis, we could not reject the null hypothesis for the equality between the estimated income elasticity of demand for imports and the hypothetical income elasticity of demand for imports that would exactly equate the actual growth rate of the country concerned for at least one of the balance of payments constrained growth models using the Wald test. This provides strong evidence that these 18 African countries were indeed balance of payments constrained during the 1960 to 2014 period. These results are consistent with Hussain (1999) who found evidence in favour of the model for 26 out of 29 African countries[75].

The balance of payments constrained growth with sustainable debt accumulation and interest rate payments abroad best explained the growth process of the region as we found evidence of the equality of the estimated income elasticity of demand and the hypothetical income elasticity of demand for 17 of the 18 countries. This highlights the important role of capital flows to the region as well as the significance of interest rate payments abroad. The results are similar to those obtained by Moreno-Brid (2003) for Mexico.

This was followed closely by the original version of the model which was able to explain the growth experience of 16 countries. This is not surprising as a study by Hussain (1999) found that the basic and extended model which allows for capital flows, were good predictors for the actual growth rate in Africa and Asia. Perraton (2003) for a group of developing countries, additionally found that the original version of the model slightly outperformed the extended model with the terms of trade as it held for the majority of the countries included in the analysis.

Using the individual country test, we could not find evidence for any of the balance of payments constrained growth models for Benin, Botswana, Chad and Namibia. This result is not surprising for Benin and Chad as the estimated balance of payments constrained growth rate given in Table 5.7 had little predictive power for the actual growth rate. In addition Botswana and Chad did not meet the stability condition for sustainable debt accumulation i.e. $(\pi \geq 1)$.

Both Namibia and Botswana ran persistent current account surpluses between the late 1980s to the 2007/2008 period. Despite this, caution is needed when rejecting the balance of payments constrained growth model for Botswana based on the Wald test as the estimated income elasticity

[75] Hussain (1999) study included North Africa, which is excluded here.

is 0.896 while the hypothetical income elasticity for the model with sustainable debt accumulation, interest payments abroad and the terms of trade is 0.81; a difference of 0.08. For Namibia data on interest payments abroad were not available. No other studies have been done for Botswana, Chad and Namibia; however a study by Perraton (2003) included Benin, found evidence in favour of the original and extended model with the terms of trade effects.

There is very little difference in the results from the Wald test when testing the balance of payments constrained growth rate estimated using the average ratios and the start of period ratios for the share of exports in imports and the share of interest payments abroad in imports. For the latter, the result is in line with the literature as we expect the share of interest payments abroad to have a limited effect on the balance of payments constrained growth rate (Thirlwall, 2012).

As the balance of payments constrained model is a long run growth model, the results from the two sub-periods are reported in Appendix L. It is interesting to note that during the overall period and the 1980 to 2014 period, the balance of payments constrained growth model with sustainable debt accumulation and interest rate payments abroad best explained the growth process of the region. However the same model performed relatively worse during the 1960 to 1980 period as it had the least predictive power. This highlights the growing role of capital flows and interest payments abroad in the region.

Table 5.8; Wald test results for the equality of the estimated income elasticity of demand, $\hat{\pi}$, and the hpothetical income elsasticity of demand, π_H, 1960 to 2014

Period	Country	$\hat{\pi}$	π_{HB}	$*\pi_{HB}$	Average π_{HBSDA}	π_{HBSDAR}	$*\pi_{HBSDART}$	$\pi_{HBSDART}$	Start π_{HBSDA}	π_{HBSDAR}	$*\pi_{HBSDART}$	$\pi_{HBSDART}$
1960-	Benin	1.142	2.233	2.569	1.640	1.512	1.727	1.553	1.440	1.426	1.586	1.466
2013	F statistic		118.00***	170.28***	20.71***	11.42***	28.58***	14.10***	7.40**	6.72**	16.46***	7.70***
	P value		0.000	0.000	0.000	0.002	0.000	0.000	0.010	0.014	0.000	0.009
1975-	Botswana	0.896	1.104	0.779	1.125	1.121	0.697	1.131	1.078	1.073	0.813	1.084
2014	F statistic		77.66***	24.59***	94.14***	90.88***	71.13***	99.13***	59.46***	56.23***	12.38***	63.44***
	P value		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
1960-	Cameroon	1.379	1.335		1.336	1.281		1.260	1.329	1.311		1.290
2014	F statistic				0.25	1.26		1.86	0.33	0.61		1.04
	P value				0.621	0.268		0.180	0.567	0.438		0.313
1960-	Chad	0.656	2.634		1.637	1.623	0.282	1.309	1.655	1.650	0.280	1.337
2005	F statistic		104.46***		38.90***	37.79***	5.69**	17.22***	40.34***	39.93***	5.75**	18.73***
	P value		0.000		0.000	0.000	0.024	0.000	0.000	0.000	0.024	0.000
1960-	Congo, Dem. Rep.	2.179	4.898	7.431	6.099	2.336	5.508	2.195	10.999	9.539	15.896	9.397
2014	F statistic		4.61**	17.19***	9.58***	0.02	6.91**	0.00	48.49***	33.77***	117.28***	32.48***
	P value		0.038	0.000	0.003	0.902	0.012	0.990	0.000	0.000	0.000	0.000
1960-	Congo, Dem. Rep. (OLS)	2.372	4.898	10.431	6.099	2.336	9.431	2.195	10.999	9.539	23.588	9.397
2014	F statistic		17.41***	177.25***	37.90***	0.00	135.99***	0.09	203.12***	140.18***	1228.56***	134.68***
	P value		0.000	0.000	0.000	0.952	0.000	0.770	0.000	0.000	0.000	0.000
1960-	Congo, Rep.	1.483	1.674	0.800	2.224	1.886	0.321	1.662	1.270	1.195	0.675	0.971
2012	F statistic		0.43	5.49**	6.73**	1.91	15.89***	0.38	0.54	0.98	7.69**	3.09*
	P value		0.522	0.032	0.019	0.186	0.001	0.548	0.474	0.337	0.013	0.098
1960-	Gabon	1.275	1.165		1.348	1.116		1.093	1.359	1.269		1.246
2014	F statistic		0.51		0.22	1.06		1.39	0.29	0.00		0.04
	P value		0.479		0.643	0.308		0.245	0.594	0.965		0.848
1960-	Gabon[76] (OLS)	0.979	1.165	1.409	1.348	1.116	1.473	0.961	1.359	1.269	1.642	1.114
2014	F statistic		0.43	2.28	1.68	0.23	3.01*	0.00	1.78	1.04	5.43**	0.22
	P value		0.517	0.137	0.201	0.633	0.089	0.948	0.188	0.313	0.024	0.638
1966-	Gambia	0.475	1.048	0.994	1.027	0.838	0.014	0.304	1.019	1.017	0.276	0.483
2013	F statistic		8.74***	7.17**	8.11***	3.51*	5.66**	0.78	7.88***	7.82***	1.05	0.00
	P value		0.005	0.011	0.007	0.069	0.022	0.383	0.008	0.008	0.311	0.967

Table continues …

[76] For Gabon both the import and export demand functions are estimated with OLS.

Period	Country	$\hat{\pi}$	π_{HB}	$*\,\pi_{HB}$	Average π_{HBSDA}	π_{HBSDAR}	$*\,\pi_{HBSDART}$	$\pi_{HBSDART}$	Start π_{HBSDA}	π_{HBSDAR}	$*\,\pi_{HBSDART}$	$\pi_{HBSDART}$
1960-	Kenya	0.986	0.857	0.900	0.871	0.875	0.867	0.828	0.892	0.893	0.878	0.846
2014	F statistic		0.37	0.16	0.29	0.27	0.31	0.55	0.20	0.19	0.26	0.43
	P value		0.547	0.687	0.591	0.604	0.578	0.461	0.660	0.663	0.613	0.513
1967-	Mali[77]	2.195	2.166	1.737	1.544	1.478	1.291	1.501	1.371	1.350	1.231	1.374
2007	F statistic		0.00	0.18	0.37	0.45	0.71	0.42	0.59	0.62	0.18	0.59
	P value		0.978	0.671	0.547	0.508	0.405	0.521	0.447	0.436	0.374	0.449
1976-	Mauritius	1.183	1.258	1.026	1.238	1.191	1.028	1.241	1.178	1.170	1.060	1.220
2014	F statistic		0.20	0.90	0.11	0.00	0.88	0.12	0.00	0.01	0.56	0.05
	P value		0.653	0.354	0.744	0.962	0.360	0.730	0.975	0.937	0.465	0.826
1980-	Mozambique	1.877	1.826	2.753	1.356	1.265	1.871	1.471	1.160	1.152	1.538	1.358
2014	F statistic		0.01	3.75*	1.33	1.84	0.00	0.81	2.52	2.57	0.56	1.32
	P value		0.910	0.066	0.261	0.189	0.989	0.378	0.127	0.123	0.461	0.263
1980-	Namibia[78]	1.946	0.896	1.067	0.904		0.901	0.743	0.892		0.909	0.731
2014	F statistic		32.35***	22.68***	31.86***		32.05***	42.46***	32.60***		31.56***	43.31***
	P value		0.000	0.000	0.000		0.000	0.000	0.000		0.000	0.000
1985-	Nigeria	0.941	1.224	1.146	1.504	0.572	1.001	1.177	1.149	0.987	1.504	1.592
2013	F statistic		0.89	0.47	3.53*	1.52	0.04	0.62	0.48	0.02	3.53*	4.72**
	P value		0.359	0.504	0.078	0.235	0.845	0.443	0.498	0.881	0.078	0.045
1960-	Senegal	1.107	1.215	0.757	1.156	1.027	0.440	0.771	1.169	1.153	0.538	0.897
2014	F statistic		1.75	18.64***	0.36	0.98	67.61***	17.18***	0.57	0.31	49.21***	7.72**
	P value		0.193	0.000	0.553	0.328	0.000	0.000	0.453	0.578	0.000	0.013
1967-	Sierra Leone[79]	2.310	2.806		2.318	1.747		2.004	2.476	2.380		2.638
2014	F statistic		0.26		0.00	0.33		0.10	0.03	0.01		0.11
	P value		0.615		0.994	0.567		0.755	0.866	0.944		0.739
1960-	South Africa	0.955	0.901	1.789	0.882	0.821	1.905	0.843	0.857	0.805	2.119	0.827
2014	F statistic		0.01	2.31	0.02	0.06	2.99*	0.04	0.03	0.07	4.50**	0.02
	P value		0.922	0.136	0.894	0.808	0.09	0.839	0.859	0.785	0.039	0.880

Table continues …

[77] For Mali the ARDL estimates for the import and export demand function are used.
[78] For Namibia there is no data on interest payments abroad.
[79] Sierra Leone uses the ARDL model.

					Average				Start			
Period	Country	$\hat{\pi}$	π_{HB}	$*\pi_{HB}$	π_{HBSDA}	π_{HBSDAR}	$*\pi_{HBSDART}$	$\pi_{HBSDART}$	π_{HBSDA}	π_{HBSDAR}	$*\pi_{HBSDART}$	$\pi_{HBSDART}$
1964-	Sudan[80]	0.957	1.435	0.646	1.435	0.978	-7.365	2.208	1.484	0.802	-8.564	2.081
2013	F statistic		5.87**	2.50	5.87**	0.01	1784***	40.26***	7.14***	0.62	2333***	32.50***
	P value		0.019	0.121	0.019	0.917	0.000	0.000	0.010	0.434	0.000	0.000
1964-	Sudan (OLS)	0.963	1.435		1.435	0.978		2.208	1.484	0.802		2.081
2013	F statistic		0.76		0.70	0.00		4.89**	0.86	0.08		3.95*
	P value		0.388		0.406	0.980		0.031	0.359	0.774		0.052
1960-	Togo (OLS)	1.608	2.143		1.690	1.555		1.534	1.442	1.408		1.387
2014	F statistic		1.16		0.03	0.01		0.02	0.11	0.16		0.17
	P value		0.286		0.870	0.914		0.888	0.738	0.687		0.678
1982-	Uganda[81]	1.553	1.775	1.713	1.345	1.365	0.753	0.781	1.257	1.294	0.689	0.710
2014	F statistic		0.87	0.45	0.78	0.64	11.43***	10.64***	1.57	1.20	13.33***	12.69***
	P value		0.369	0.514	0.395	0.440	0.005	0.006	0.233	0.294	0.003	0.003
1982-	Uganda (OLS)	2.061	1.775		1.345	1.365		0.912	1.257	1.294		0.841
2014	F statistic		0.22		1.37	1.29		3.52*	1.72	1.57		3.96*
	P value		0.644		0.252	0.265		0.071	0.200	0.221		0.056
1960-	Zambia	4.562	2.702	8.441	2.290	0.085	5.203	0.853	2.065	1.540	5.901	2.308
2014	F statistic		0.74	3.20*	1.10	4.26*	0.09	2.92	1.32	1.94	0.38	1.08
	P value		0.406	0.097	0.314	0.059	0.772	0.111	0.270	0.187	0.547	0.317
1976-	Zimbabwe	1.167	1.124	27.399	1.097	0.440	20.622	1.054	1.111	1.093	24.110	1.708
2014	F statistic		0.03	12190***	0.09	9.37***	6705***	0.23	0.06	0.10	9324***	5.18**
	P value		0.857	0.000	0.770	0.005	0.000	0.638	0.815	0.758	0.000	0.032

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period.
π_{HB}, is the hypothetical income elasticity of demand from the original "weak" version of the balance of payments constrained growth model
$*\pi_{HB}$, is the hypothetical income elasticity of demand from the original "strong" version of the balance of payments constrained growth model
π_{HBSDA}, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation
π_{HBSDAR}, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation and interest payments abroad
$*\pi_{HBSDART}$, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports.
$\pi_{HBSDART}$, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation, interest payments and the terms of trade
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

[80] Sudan uses the ARDL estimate for both the export and import demand function.
[81] For Uganda both import and export demand functions are estimated with the ARDL model.

Our second formal test for the balance of payments constrained model can be seen in Table 5.9. We regressed each of our calculated balance of payments constrained growth rates on the actual growth rate for all 22 countries. We use two different specifications; with and without a constant. When we exclude the intercept, we find strong evidence in support of the balance of payments constrained model as the coefficient on the actual rate of growth ranged from 0.846 to 1.14. In addition, using the Wald test, we accept the hypothesis that the coefficient is equal to one. These results confirm and strengthen the results obtained from the single country tests. As Benin, Botswana, Chad and Namibia were included in the regressions below, it would be erroneous to dismiss the balance of payments constrained growth as being irrelevant for these countries. The results below use the logarithmic form, please see Appendix M for the results from the alternative level specification.

Table 5.9; Regression results for the balance of payments constrained growth, y_B, and the actual growth rate (logarithmic form)

	Dependent variable	Constant, α	Coefficient on the actual growth rate, β	R^2	F statistic	Wald test (β=1) P value	Wald test (α=0) P value
	y_B	0.382 (0.366)	0.834*** (0.268)	0.325	9.65***	0.544	0.308
	y_B		1.104*** (0.072)	0.918	234.95***	0.161	
	$* y_B$	2.371*** (0.578)	-0.539 (0.427)	0.102	1.59	0.002***	0.001***
	$* y_B$		1.132*** (0.184)	0.715	37.75***	0.482	
Average[N]	y_{BSDA}	0.617 (0.791)	0.712 (0.579	0.070	1.51	0.625	0.443
	y_{BSDA}		1.148*** (0.153)	0.726	55.86***	0.344	
	y_{BSDAR}	-0.396 (0.932)	1.403** (0.678)	0.192	4.28**	0.559	0.676
	y_{BSDAR}		1.126*** (0.184)	0.663	37.36***	0.499	
	$* y_{BSDART}$	1.960** (0.798)	-0.457 (0.591)	0.044	0.60	0.028**	0.029**
	$* y_{BSDART}$		0.921*** (0.213)	0.570	18.56***	0.720	
	y_{BSDART}	-0.230 (0.997)	1.008 (0.731)	0.091	1.90	0.990	0.819
	y_{BSDART}		0.846*** (0.195)	0.483	18.71***	0.441	

Table continues …

	Dependent variable	Constant, α	Coefficient on the actual growth rate, β	R^2	F statistic	Wald test (β=1) P value	Wald test (α=0) P value
<u>Start</u>[N]	y_{BSDA}	0.793 (0.671)	0.417 (0.492)	0.036	0.72	0.251	0.252
	y_{BSDA}		0.977*** (0.136)	0.719	51.36***	0.869	
	y_{BSDAR}	0.433 (0.513)	0.723 (0.701)	0.038	0.71	0.284	0.316
	y_{BSDAR}		0.941*** (0.143)	0.692	42.86	0.685	
	$*\,y_{BSDART}$	2.522** (0.906)	-0.854 (0.670)	0.103	1.62	0.015**	0.014**
	$*\,y_{BSDART}$		0.924*** (0.242)	0.491	14.50***	0.759	
	y_{BSDART}	1.113 (0.724)	0.118 (0.531)	0.002	0.05	0.112	0.140
	y_{BSDART}		0.904*** (0.146)	0.644	38.0***	0.522	

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered.
Standard errors are in parenthesis
y_B, is the “weak” original version of the balance of payments constrained growth model
$*\,y_B$, is the “strong” original version of the balance of payments constrained growth model
y_{BSDA}, is the balance of payments constrained growth with sustainable debt accumulation
y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad
$*\,y_{BSDART}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports.
y_{BSDART}, is the balance of payments constrained growth with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

As a final test to the model, we carry out panel Granger causality analysis between the actual rate of growth and the balance of payments constrained growth rate (Lanzafame, 2014). A summary of the results for the growth in exports, x and income, y are given in Table 5.10.

Table 5.10; Summary of panel VAR results for, x and, y 1960 to 2014

	Annual data		5 year average	
	x	x	x	x
x_{t-1}	-0.0006	0.0006	0.340**	0.559***
	(0.063)	(0.064)	(0.160)	(0.165)
y_{t-1}	0.406***	0.493***	-0.129	-0.013
	(0.123)	(0.104)	(0.255)	(0.267)
Trend		0.0005		0.002
		(0.0004)		(0.003)
	y	y	y	y
x_{t-1}	0.034**	0.037**	0.156***	0.152**
	(0.014)	(0.014)	(0.059)	(0.070)
y_{t-1}	0.138**	0.184***	-0.125	0.018
	(0.055)	(0.054)	(0.138)	(0.132)
Trend		0.0003**		0.004***
		(0.0001)		(0.001)
Lag order	1	1	1	1
Instruments	3	3	2	3
MBIC	-48.515	-44.970	-16.652	-29.590
MAIC	-9.790	-6.246	-5.570	-9.075
MQIC	-24.556	-21.011	-10.069	-17.368
J statistic	6.209	9.753	2.429	6.924
J statistic P value	0.623	0.282	0.657	0.544
No of observations	935	935	118	96
No of cross sections	22	22	22	22
LM test for autocorrelation (P value)	0.679	0.679	0.407	0.405
Stability condition	Stable	Stable	Stable	Stable
Panel Granger Causality (P values)				
$y \rightarrow x$	0.001***	0.000***	0.613	0.960
$x \rightarrow y$	0.020**	0.012**	0.009***	0.030**

Note: Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
The stability graphs can be seen in Appendix Q

The chosen panel VAR model has a lag order of 1, where the MBIC, MAIC and MQIC are minimised. The J statistic and the corresponding P value is insignificant indicating that the instruments used are valid. The results from the Granger causality test indicate that there is bidirectional causality running from the growth of exports, used as a proxy for the balance of payments constrained growth rate and the growth of income. This result remains consistent with the inclusion of a trend. This further supports the hypothesis that the sub-Saharan countries included in the study were balance of payments constrained (Lanzafame, 2014).

The analysis using the 5 year non overlapping average strengthens the argument. The specification with and without a trend showed there was unidirectional causality running from the balance of payments constrained growth rate to the actual growth rate. These results support the balance of payments constrained growth rate as being a long run growth model.

The summary of results for the balance of payments constrained growth rate with debt accumulation and interest payments abroad, y_{BSDAR} is given in Table 5.11.

Table 5.11; Summary of panel VAR results for, y_{BSDAR} and, y 1971 to 2013

	Annual data		5 year average	
	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}
$y_{BSDAR_{t-1}}$	-0.020***	-0.017***	0.023	0.033
	(0.002)	(0.002)	(0.085)	(0.089)
y_{t-1}	0.953	3.744*	-37.644	43.021
	(2.898)	(2.161)	(150.053)	(108.723)
Trend		2.648*		-43.952
		(1.389)		(100.714)
	y	y	y	y
$y_{BSDAR_{t-1}}$	0.0002**	0.0002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
y_{t-1}	0.315***	0.314***	-0.042	0.215
	(0.092)	(0.083)	(0.286)	(0.276)
Trend		0.055**		0.609**
		(0.023)		(0.255)
Lag order	1	1	1	1
Instrument	3	3	2	2
MBIC	-40.743	-42.942	-16.262	-11.821
MAIC	-4.032	-6.230	-6.538	-2.098
MQIC	-18.198	-20.396	-10.447	-6.006
J statistic	11.967	9.769	1.461	5.901
J statistic P value	0.152	0.281	0.833	0.206
No of observations	727	727	84	84
No of cross sections	21	21	20	20
LM test for autocorrelation (P value)	0.102	0.102	0.000	0.000
Stability condition	Stable	Stable	Stable	Stable
Panel Granger Causality (P values)				
$y \rightarrow y_{BSDAR}$	0.742	0.083*	0.802	0.692
$y_{BSDAR} \rightarrow y$	0.011**	0.004***	0.000***	0.000***

Note: Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
The stability graphs can be seen in Appendix Q
y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad

The Granger causality tests provide evidence at the 99% confidence level that there is unidirectional causality running from, y_{BSDAR} to, y. This result holds when using annual data as well as the 5 year non overlapping average. The results are consistent with those given in Table 5.10 and show that the region was indeed balance of payments constrained. When using the 5 year average, the MBIC, MAIC and MQIC were minimised at a lag order of one, however the presence of autocorrelation as detected by the LM test implies that a higher lag order may be more appropriate as autocorrelation can be corrected with the addition of an adequate number of lags. The results remain robust and are given in Appendix N.

The results from the Granger causality analysis confirm our hypothesis that the 22 sub-Saharan African countries included in the analysis were balance of payments constrained. The results from the 5 year non overlapping average further strengthen the claim that the balance of payments constrained growth model is a long run model.

5.3. Concluding Remarks

The balance of payments constrained growth rate was estimated for 22 sub-Saharan African countries. The model proved to have strong predictive power as it was able to closely predict the growth rate of 17 countries with an absolute error of less than 0.5. This figure increased to 19 at an absolute error below one.

When formally testing the model for each individual country, by testing the equality between the estimated income elasticity of demand for imports and the hypothetical income elasticity of demand for imports that would exactly equate the actual rate of growth, again we find strong evidence in support of the balance of payments constrained growth model. For 18 countries we found evidence in support of at least one of the balance of payments constrained growth models.

The model which accounts for sustainable debt accumulation and interest rate payments abroad outperformed all the other models both in its predictive power and when testing the equality of the estimated and hypothetical income elasticities of demand. It was able to explain the growth experience of 77.3% of the countries included in the study. This highlights the importance of capital flows and interest rate payments in the region.

Unsurprisingly, the same countries where the balance of payments constrained growth model had poor predictive power, failed the formal test. These are Benin, Botswana, Chad and Namibia. Caution however is needed when rejecting the balance of payments constrained growth rate for Namibia as data on interest payments abroad was not available. By applying only the simple balance of payments constrained growth model, we could erroneously reject the model when it actually does apply. This would have been the case for the Democratic Republic of Congo and Gambia. It is therefore important to account for capital flows and interest payments abroad.

When pooling the results from the 22 countries, we find strong evidence in favour of all 6 models for the balance of payments constrained growth for the full sample of countries, including Benin, Botswana, Chad and Namibia. These results strengthen those obtained from the single country tests.

Our results provide strong evidence that the demand-led long run growth model developed by Thirlwall (1979), is relevant for the sub-Saharan African region. However, in the long run, growth in potential output should equal growth in demand. The next section therefore analyses the long run relationship between supply and demand for the sub-Saharan African region as well as the adjustment mechanism that reconciles the two.

Chapter 6

6. THE ADJUSTMENT TO THE STEADY STATE

Our results from chapter 4 on the endogeneity of the natural rate of growth provided empirical evidence that demand might matter for long run growth and development. Chapter 5 therefore applied the balance of payments constrained growth model which is a long run demand-led growth model. The results provide evidence that the sub-Saharan African region was balance of payments constrained during the period analysed. However, in the steady state, growth in demand must equal growth in potential output, i.e. demand must equal supply. How the adjustment process takes place is imperative as it will shed light on the debate on whether it is demand that adjusts to supply (Palley, 2003), supply to demand (Setterfield, 2006), or both processes are operating at the same time (Setterfield, 2006; Lanzafame, 2014).

This chapter therefore aims to answer the research sub-question, (iv) What is the long run relationship between the natural rate of growth and the balance of payments constrained growth rate. This is done through panel Granger causality analysis between the natural rate of growth, y_N, and the balance of payments constrained growth, y_B.

6.1. Demand and Supply Led Debate within the Balance of Payments Constrained Model

Part of the debate on growth economics rests on the question of whether the economy is demand or supply driven. While neoclassical and new endogenous growth theories are criticised for not sufficiently accounting for demand factors, Keynesian growth theories are likewise criticised for neglecting the supply side of the economy. This is of significance for in the long run, growth in demand and capacity have to be equal, if not, there would be ever growing excess capacity or growing excess demand, a feature which is not prevalent in modern economies.

The balance of payments constrained growth model, like other Keynesian models has been criticised by Palley (2003) for the same "pitfall" in failing to sufficiently account for the supply side of the economy. The inconsistency stems of the "dual requirement" of the current account balance as growth in exports must equal growth in imports (x=m), while at the same time the capacity balance must be met, i.e. in the long run, growth in demand must equal growth in capacity or potential output.

In the post-Keynesian literature, the natural rate of growth, y_N, is defined as the growth rate required to keep unemployment constant given growth in the labour force and labour productivity (Harrod, 1939). It can therefore be taken as the growth in a country's productive capacity (Palley, 2003; Setterfield, 2006; Lanzafame, 2014). Hence in the long run, $y_B = y_N$.

Based on the rationale that imports are driven by bottlenecks which become more rampant with decreases in excess capacity[82] and unemployment, Palley (2003) reconciles the inconsistency by taking the income elasticity of demand for imports to be endogenous to the degree of capacity utilisation, rising in periods of overcapacity utilisation and falling in periods of under capacity utilisation. There is an upper and lower limit to capacity utilisation of 100% and 0% respectively. The adjustment to the steady state following an increase in excess capacity ($y_B < y_N$), therefore takes place by "pulling down" or reducing the income elasticity of demand for imports, thereby relaxing the external constraint on growth and allowing aggregate demand to increase until the balance of payments constrained growth rate is consistent with the underlying capacity growth process (Palley, 2003).

The steady state rate of growth is determined by supply side factors when the above approach proposed by Palley (2003) is used to reconcile demand and capacity growth. Unsurprisingly, this approach has been criticised by Setterfield (2006) who recognised that there are "multiple solutions" consistent with the balance of payments constrained theory of growth. He proposes an alternative approach which involves treating productivity growth as endogenous to the rate of capacity utilisation. In this case, decreases in excess capacity induces an increase in productivity growth.

> *"The hypothesis here is that the extent to which any given rate of output growth will induce productivity growth (ie., the precise size of the Verdoorn coefficient) is a direct function of the rate of capacity utilisation… more productivity growth is induced by a goods market that is both tight and rapidly expanding" (Setterfield, 2006, p.54).*

If growth in demand exceeds growth in potential output ($y_B > y_N$), increasing rates of capacity utilisation would cause the Verdoorn coefficient[83] to increase as firms become more willing to engage in innovation, technical and organisational change, thereby raising the rate of productivity growth, which in turn raises the growth of potential output until actual and potential growth rates are reconciled. This approach is consistent with the endogeneity of the natural rate of growth

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[82] Excess capacity is defined as the level of output divided by the level of capacity (Palley, 2003).

[83] When, $\lambda = c_0 + c_1 g^a$, where λ is the growth in labour productivity, g^a is actual rate of growth for a given country and c_1 is the Verdoorn coefficient which captures the sensitivity of productivity growth to actual growth, "as a result of static and dynamic increasing returns" (Setterfield 2006, p.54).

assumption. According to Setterfield (2006), both adjustment processes described above may be operating at the same time as they are not mutually exclusive. The nature of the adjustment process for the sub-Saharan African region will be analysed through a series of panel Granger causality tests.

6.2. Data and Methodology

A panel Vector Autoregressive (VAR) model within a Generalised Method of Moments (GMM) framework is applied (Abrigo and Love, 2015). We then carry out panel Granger causality tests to determine the direction of causality between the natural rate of growth and the balance of payments constrained growth rate. This section outlines the data used as well as the estimation model.

6.2.1. Data

To analyse the adjustment process between the natural rate of growth and the balance of payments constrained growth rate, we use an unbalanced panel dataset for the 1991 to 2013 period[84]. The 22 countries used in the balance of payments constrained growth analysis are included in the panel.

The weak version of Thirlwalls law is given by,

$$y_B = x/\pi \qquad \text{(Equation 2.45)}$$

where the balance of payments constrained growth rate $y_{B,}$ is equal to the growth in exports, x, divided by the import elasticity of demand for imports, π. As π, is constant, x can be used as a proxy for the balance of payments constrained growth rate as done by Lanzafame (2014). This is appropriate as the empirical tests for the balance of payments constraint growth rate given in chapter 5, showed that the original balance of payments constrained growth model was a good predictor of growth in the region as it was able to predict the actual growth rate for 73% of the countries included in the analysis. This finding is in line with others who found the original model to perform as well as, or in certain cases outperform the extended models (Hussain, 1999; Perraton, 2003).

In addition to the growth in exports, we make use of the estimated balance of payments constrained growth rate with sustainable debt accumulation and interest payments abroad as it was the best predictor of growth for the region[85]. A limitation of using the extended model is the error in

[84] The time frame used is limited due to data availability on labour productivity which starts in 1991.
[85] The balance of payments constrained growth rate with sustainable debt accumulation and interest payments abroad accurately predicted the growth rate for 77% of the countries included in the analysis.

variables problem, as it is derived from prior estimation coefficients which have associated standard errors. This problem is avoided when using the simple “weak” version of the model.

In line with Lanzafame (2014), as a proxy for the natural rate of growth, we use the labour force in efficiency units, lfe. This is measured as the sum of two growth rates, i.e. productivity growth and growth in the labour force. Please see Appendix A for a full description of the data used and sources.

The Unemployment rate is included as a control variable.

We average out short term fluctuations by using a 4 year non-overlapping average. This is preferred to the 5 year average due to the short time series of the data. As the business cycle is typically 3 to 5 years, a 4 year average is a reasonable number as it allows us to focus on the long run adjustment process, which is the main aim of this chapter.

6.2.2. Estimations

In this section we outline the panel unit root tests used to pre-test the stationarity of the data. We then outline the chosen panel VAR model as well as the set criteria for choosing the appropriate specification.

6.2.3. Panel Unit Root Tests

We make use of the Maddala and Wu (MW) unit root test, also known as a Fisher type test. It is the most appropriate for unbalanced panel data compared to the Im, Pesaran and Shin test which is restricted to balanced panel data (Hoang and McNown, 2006). The null hypothesis is that each series in the panel contains a unit root for all countries and the alternative hypothesis is that some, not all, of the countries have a unit root (Baltagi, 2005).

The MW test combines the P values from each individual country unit root test based on the Augmented Dickey Fuller (ADF) test or the Phillips Perron (PP) test (Baltagi, 2005). We apply both as the PP test corrects for serial correlation and heteroscedasticity. We make use of the three methods proposed by Choi (2001) to combine the P values by using the inverse χ^2, inverse-normal and inverse logit transformation. The P values are derived by Monte Carlo simulations. When carrying out the tests we account for a trend as well as demean by removing cross sectional means. The results are reported in Appendix 0. The null hypothesis that all countries in the panel contain a unit root is strongly rejected for all the variables used. We therefore continue our analysis using the panel VAR model.

6.2.4. Panel Granger Causality Analysis

A panel VAR model will be applied in order to determine the direction of causality from the growth in the labour force in efficiency units, which is used as a proxy for the supply side and growth in exports as well as the estimated balance of payments constrained growth rate with sustainable debt accumulation and interest payments abroad, which is used as a proxy for the demand side.

The panel VAR model is preferred as the underlying estimation model to carry out the related Granger causality tests as all the variables included in the system of equations are treated as endogenous. According to Holtz-Eakin et al (1988) estimating the model as a system of equations may result in efficiency gains. We estimate the panel VAR model within a GMM framework (Abrigo and Love, 2015).

The forward orthogonal deviation transformation is applied as it is more appropriate for unbalanced panels than the first difference transformation due to the loss of data in the latter (Arellano and Bover, 1995). This also allows us to use the lagged values as valid instruments as they are not included in the transformation. The number of instruments applied should be minimised in order to avoid the shortcomings pointed out by Roodman (2009) related to the small sample problem resulting in "weakened specification tests" which imply that results are valid when they are not[86]. However the condition that the number of instruments i, be larger than the lag order chosen m, i.e. $i>m$, is met (Arellano and Bover, 1995). The Hansen (1982) J-test statistic and its corresponding P value will be applied to test the validity of the instruments used. The null hypothesis is the joint validity of all instruments.

The optimum lag order is selected based on consistent Model and Moment Selection Criteria (MMSC), based on the J test statistic for testing over-identifying restrictions (Andrews and Lu, 2001) which minimises the MMSC-Bayesian information criterion (MBIC), the MMSC-Akaike's information criterion (MAIC) and the MMSC-Hannan and Quinn information criterion (MQIC). We combine this with a second method proposed by Holtz-Eakin et al (1988) where we initially assume a lag length of 3. The significance of the lagged variable will be taken into consideration as well as the stability of the model. In cases where the magnitude is small and the coefficient insignificant, lower lag orders will be tried.

[86] This is due to endogenous variables being overfitted as well as the problems specific to feasible efficient GMM when identifying moments between the instruments and the errors (Roodman, 2009).

6.3. Results

A summary of the results for the adjustment process between the balance of payments constrained growth rate and the natural rate of growth are given in Table 6.1.

Table 6.1; Summary of panel VAR results for, x and, lfe 1991 to 2014

	Annual data				4 year average			
	x	x	x	x	x	x	x	x
x_{t-1}	0.029	0.057	0.031	0.052	0.289	0.433	0.208	0.597
	(0.104)	(0.105)	(0.107)	(0.105)	(0.734)	(0.395)	(0.260)	(0.911)
lfe_{t-1}	0.517*	0.553	0.512*	0.566*	-0.476	0.785	-1.671	-0.492
	(0.290)	(0.237)	(0.277)	(0.303)	(2.987)	(1.237)	(1.060)	(2.297)
Trend		0.000		0.0007		-0.013		0.014
		(0.001)		(0.001)		(0.020)		(0.055)
u			0.011	0.034			0.085	0.111
			(0.024)	(0.027)			(0.055)	(0.214)
	lfe	lfe	lfe	lfe	lfe	lfe	lfe	lfe
x_{t-1}	0.045**	0.057***	0.047***	0.054***	0.141	0.135	0.132*	0.157**
	(0.018)	(0.019)	(0.018)	(0.018)	(0.307)	(0.089)	(0.073)	(0.078)
lfe_{t-1}	0.009	0.141	0.078	0.146	1.487	0.526*	0.235	0.495
	(0.110)	(0.117)	(0.097)	(0.113)	(1.269)	(0.308)	(0.314)	(0.358)
Trend		0.001*		0.0009**		-0.007		-0.003
		(0.000)		(0.0004)		(0.005)		(0.004)
u			0.001	0.016*			-0.0005	0.002
			(0.009)	(0.008)			(0.012)	)0.012)
Lag order	1	1	1	1	1	1	1	1
Instrument	3	3	3	3	2	2	2	2
MBIC	-40.970	-33.759	-37.932	-36.307	-12.475	-10.798	-13.600	-15.028
MAIC	-8.979	-1.767	-5.940	-4.316	-5.339	-3.661	-6.463	-7.891
MQIC	-21.644	-14.432	-18.606	-16.981	-7.985	-6.308	-9.110	-10.538
J statistic	7.020	14.232	10.059	11.683	2.660	4.338	1.536	0.108
J statistic P value	0.534	0.075	0.260	0.165	0.616	0.362	0.820	0.998
No of observations	403	403	403	403	44	44	44	44
No of cross sections	22	22	22	22	22	22	22	22
LM test for autocorrelation (P value)	0.778	0.781	0.886	0.887	0.748	0.828	0.934	0.970
Stability condition	Stable	Stable	Stable	Stable	Not stable	Stable	Stable	Stable
	Panel Granger Causality (P values)							
$lfe \rightarrow x$	0.074*	0.020**	0.065*	0.062*	0.873	0.525	0.115	0.830
$x \rightarrow lfe$	0.012**	0.003***	0.009***	0.004***	0.178	0.131	0.071*	0.045**

Note: Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level
The stability graphs can be seen in Appendix R

A panel VAR with a lag order of 1 is used to analyse the relationship between the balance of payments constrained growth rate, x and the natural rate of growth, lfe. The MBIC, MAIC and

MQIC were minimised at a lag order of one. The results from the Granger causality analysis using annual data shows that there is bidirectional causality running from the balance of payments constrained growth rate to the natural rate of growth and vice versa. This result is consistent with the inclusion of a trend as well as the unemployment rate as a control variable. The results support the claim by Setterfield (2006) that both demand and supply mechanisms may operate at the same time to maintain equality between growth in demand and capacity.

Interestingly, when using the 4 year average, the Granger causality results provide evidence of unidirectional causality running from the balance of payments constrained growth to the natural rate of growth. This result is the same when analysed using the balance of payments constrained growth rate with sustainable debt accumulation and interest payments abroad, y_{BSDAR} as shown in Table 6.2. This is consistent with the proposed adjustment mechanism to the steady state by Setterfield (2006); in the long run demand may be more important due to its effect on productivity growth as governed by Verdoorn's laws.

Table 6.2; Summary of panel VAR results for, y_{BSDAR} and, lfe 1991 to 2013

	Annual data				4 year average[N]			
	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}	y_{BSDAR}
$y_{BSDAR_{t-1}}$	0.159	0.188	0.134	0.328***	0.017	0.0008	0.006	0.002
	(0.108)	(0.132)	(0.117)	(0.104)	(0.038)	(0.014)	(0.015)	(0.012)
lfe_{t-1}	-27.329***	-26.731***	-27.547***	-21.576***	11.177	0.806	3.132	2.308
	(2.644)	(2.512)	(3.694)	(6.011)	(26.307)	96.934)	(17.453)	(5.118)
Trend		0.635		2.883		-4.977		-8.388
		(1.757)		(3.439)		(8.169)		(10.878)
u			-63.477	56.603			17.453	-10.239
			(63.617)	(41.084)			(53.175)	(44.099)
	lfe	lfe	lfe	lfe	lfe	lfe	lfe	lfe
$y_{BSDAR_{t-1}}$	-0.006***	-0.006***	-0.006***	-0.021***	-0.001**	-0.0008**	-0.001***	-0.0008*
	(0.002)	(0.001)	(0.001)	(0.005)	(0.001)	(0.0004)	(0.0002)	(0.0004)
lfe_{t-1}	0.689***	0.698***	0.690***	0.428	0.234	0.521	0.356*	0.546
	(0.079)	(0.079)	(0.074)	(0.294)	(0.423)	(0.319)	(0.195)	(0.336)
Trend		0.036		-0.390		-0.101		-0.121
		(0.057)		(0.325)		(0.299)		(0.332)
u			-0.814	-10.269			0.530	0.542
			(0.904)	(6.309)			(1.542)	(1.051)
Lag order	1	1	1	1	1	1	1	1
Instrument	5	5	5	6	2	2	2	2
MBIC	-69.245	-59.055	-70.576	-89.444	-13.927	-14.203	-13.929	-14.524
MAIC	-9.002	1.187	-10.333	-15.502	-7.273	-7.549	-7.275	-7.869
MQIC	-33.061	-22.871	-34.392	-45.100	-9.660	-9.937	-9.662	-10.257
J statistic	22.997	33.187	21.666	24.497	0.726	0.450	0.724	0.130
J statistic P value	0.113	0.006***	0.154	0.221	0.947	0.978	0.948	0.997
No of observations	319	319	319	298	39	39	39	39
No of cross sections	21	21	21	21	21	21	21	21
LM test for autocorrelation (P value)	0.509	0.474	0.432	0.401	0.000	0.000	0.000	0.000
Stability condition	Stable	Stable	Stable	No stable	Stable	Stable	Stable	Stable
	Panel Granger Causality (P values)							
$lfe \rightarrow y_{BSDAR}$	0.000***	0.000***	0.000***	0.000***	0.671	0.907	0.691	0.652
$y_{BSDAR} \rightarrow lfe$	0.002***	0.000***	0.002***	0.000***	0.039**	0.050**	0.000***	0.076*

Note: Standard errors are in parenthesis

y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad.

For y_{BSDAR} we use a 5 year moving average to smooth the growth of exports, then take 4 year non-overlapping averages. Autocorrelation is present in the 4 year average results however due to the limited time series, it was not possible to correct for autocorrelation as higher lag order specifications failed the stability test.

*** Indicates significance at the 99% level

** Indicates significance at the 95% level

* Indicates significance at the 90% level

The stability graphs can be seen in Appendix R

6.4. Concluding Remarks

This chapter analysed the adjustment mechanism between the natural rate of growth and the balance of payments constrained growth rate using panel Granger causality tests based on a panel VAR model. The results using annual data provided evidence of bidirectional causality running from the balance of payments constrained growth rate to the natural rate of growth. This provides empirical evidence supporting Setterfield's (2006) claim, that both supply and demand side mechanisms may operate at the same time to restore long term capacity balance.

The results from the 4 year averaged data showed unidirectional causality running from the balance of payments constrained growth rate to the natural rate of growth. This provides further support for Setterfield's (2006) second argument, that long run capacity balance is brought about by changes in the natural rate of growth as a result of changes in productivity as determined by the Verdoorn coefficient. The fact that Granger causality tests revealed unidirectional causality when using the 4 year averaged data, further suggests that demand is more important in the medium to long term than supply.

The results further support the theoretical expectations of the Harrod (1939) model extended by Thirlwall (2001) to an open economy growth model, that the main constraint to long run growth is the balance of payments equilibrium growth rate. One of the implications of the balance of payments constrained growth model is that the structure of production and exports determines the income elasticity of demand for exports which therefore determines the rate of growth of one country relative to another. What a country exports has to do with how its economic activity is structured. Changing the structure of the economy is therefore imperative in order to bring about long term economic growth and development in the region. This is discussed in chapter 7.

Chapter 7

7. IMPLICATIONS OF THE NATURAL RATE OF GROWTH AND BALANCE OF PAYMENTS CONSTRAINED GROWTH

This chapter looks at the policy implications we can draw from our empirical findings in relation to the natural rate of growth and the balance of payments constrained growth rate for the sub-Saharan African region. Central to the discussion, is what these results mean in terms of structural transformation, identified as imperative for sustainable economic growth and development.

Chapter 4 provided empirical evidence that the natural rate of growth is endogenous to the actual rate of growth. As the natural rate of growth is defined as growth in the labour force in efficient units, it accounts for the supply side of the economy. The results therefore reveal that within limits, supply responds to both internal and external demand, suggesting that demand matters for both short and long run growth. We therefore begin with the implications of this finding as well as the role of regional integration in relaxing the demand constraint.

The results from chapter 5 provide empirical evidence that the sub-Saharan region was balance of payments constrained. The model which accounted for sustainable debt accumulation and interest payments abroad best described the growth process of the region. Growth in exports were identified as the main constraint to growth. These in turn depend on the income elasticity of demand for exports multiplied by growth in world income.

The income elasticities of demand are determined by supply side factors. What a country exports has to do with the way its economic activity is structured (Hausmann et al, 2007). We therefore take a look at the structure of the sub-Saharan African economies, taking into account natural endowment and historical incidents. We highlight some of the problems associated with specialising in the production and export of primary products, emphasising the need for structural change in favour of the production of manufactured goods.

We explore the role of industrial policy for enhancing sustainable "job creating" growth through structural change along Kaldorian lines. Finally, we discuss some of the possible issues related to financing structural transformation and the role of regional integration in overcoming these challenges.

7.1. The Role of Demand and Increasing Returns to Scale

The central role of demand in the economics growth literature has long been recognised. As famously articulated by Smith (1776, p.21),

> *"It is the power of exchanging that gives occasion to the division of labour, so the extent of this division must always be limited by the extent of that power, or, in other words, by the extent of the market. When the market is very small, no person can have any encouragement to dedicate himself entirely to one employment, for want of the power to exchange all that surplus part of the produce of his own labour, which is over and above his own consumption, for such parts of the produce of other men's labour as he has occasion for."*

The role of the market was so imperative that it was described as one of the greatest gains resulting from colonisation. For the imperial state, by opening an "inexhaustible market" for their own manufactured products in their foreign territories, enabled the further division of labour leading to an increase in output (Smith, 1776, p.358). The size of the market can be described as, "the capacity to absorb a large annual output of goods" (Young, 1928, p.533). In this sense it is measured as the buying power of the population.

The concept was refined by Young (1928) who made the distinction between economies of scale and secondary order economies. The first are brought about due to the division of labour which breaks down complex processes into simpler ones which at times may be mechanised resulting in the further division of labour. Secondary order economies relate to specialised production appliances. The division of labour which emanates from the growth of the market is therefore the driver of increasing returns. This builds on the concept of internal economies of scales that arise within a firm as the scale of production increases and external economies of scale which are associated with changes to the organisation of the industry as a whole (Marshall, 1890).

> *"With the extension of the division of labour among industries the representative firm, like the industry of which it is a part, loses its identity. Its internal economies dissolve into the internal and external economies of the more highly specialised undertakings which are its successors, and are supplemented by new economies" (Young, 1928, p.538).*

The relationship between growth in productivity and output has received substantial attention in the post-Keynesian literature. First formalised and empirically tested by Verdoorn (1949), the law named after the author postulates that there is a positive and stable relationship over time between growth in labour productivity and output due to the division of labour resulting from increases in the volume of production (Verdoorn, 1949). Kaldor (1967) developed the argument further attributing the empirical relationship between productivity and output to dynamic increasing returns to scale, for the greater division of labour results in, "the development of more skill and know-how, which, in turn lead to more innovations and improvements in design" (Kaldor, 1967, p.13).

An increase in output stimulates induced investment (Hicks, 1950). The decision to invest is based on future expectations regarding profitability as well as animal spirits described as the "spontaneous urge to action rather than inaction" (Keynes, 1936, p.81). Previously unattractive investment decisions, following an enlargement of the market, would now become viable due to the greater division of labour which allows for greater economies of scale.

These theoretical expectations are in line with our results which provide evidence that supply in sub-Saharan Africa is endogenous to demand changes. Granger causality analysis showed that within limits, it is supply that adjusts to demand, through the positive effects that growth in output has on productivity and investment. This relationship is strongest for low income countries due to their low level of economic development. *Regional integration which reduces trade barriers between African countries would increase the size of the market. This in turn would stimulate "fresh" investment and enhance productivity growth as a result of static, dynamic and macro increasing returns to scale, i.e. Verdoorn's law.*

7.2. The Importance of Exports

There are three sources of demand for a country's products, namely consumption, investment and net exports. In an open economy, exports are the "only" true component of autonomous demand, working through the Hicks super-multiplier to allow other components of demand to grow faster. Many export-led growth models, including the balance of payments constrained model, which proved to hold for the region, are based on this premise. In addition, through their generation of foreign exchange, they represent the only component of demand that can pay for import requirements, mainly in the form of capital goods and equipment, vital for development (Thirlwall, 1997).

7.2.1. Increasing Exports along Static Harrodian Lines

As expected with export-led growth models, a countries growth performance can be improved by increasing exports. We therefore outline the determinants of exports along the lines of static comparative advantage.

According to Harrod (1957), the value of exports depends on the domestic money rates of reward on factors of production, the domestic efficiency of factors of production, world demand and prices, and the profit element which is particularly important for future or "fresh" investment. As a country cannot control world demand and prices, its exports largely depend on the first two factors.

Rates of reward on factors of production are determined by the bargaining power between different factors. Attempts by policy makers to change these rates would be met with resistance. An easier way of adjusting the rate of reward to factors of production relative to the world in order to increase competitiveness would be to devalue the currency in the case of a fixed exchange rate (Harrod, 1957), or allow the currency to depreciate when some form of a floating exchange rate regime is used.

A devaluation in order to improve the balance of payments condition will only be successful in the period concerned if the Marshall-Lerner condition holds. Only five of the 22 countries included in the balance of payments analysis meet this condition. These were Benin, Botswana, Kenya, Sudan and Zimbabwe. It should be noted that Zimbabwe currently does not have a sovereign currency and instead uses a basket of foreign currencies. A devaluation of the exchange rate policy is therefore not possible.

Devaluation or depreciation may be a successful policy tool for altering the rates of reward on the factors of production in the small group of countries; Benin, Botswana, Kenya and Sudan. However it is unlikely to improve the balance of payments position in the rest of the countries which make up the majority of the sample. This finding, that the elasticity conditions are generally not met in developing countries is in line with the work carried out by Hussain (1995). The burden of improving sub-Saharan Africa's export position therefore rests on enhancing the domestic efficiency of factors of production in areas where the region holds comparative advantage. If not, income will adjust, through the Harrod foreign trade multiplier, to restore balance in the balance of payments.

The main difference between the balance of payments constrained growth model and other export-led growth models is that its emphasis is not solely on the growth of exports, but on the demand for imports as captured by the income elasticity of demand for imports. The latter is determined, along with the income elasticity of demand for exports, by non-price based factors related to the structure of production.

7.2.2. Criticism Against Export-Led Growth Models

Export-led growth models have been widely criticised. According to Blecker (2000), it suffers from a "fallacy of composition" when many countries simultaneously rely on export-led growth policies resulting in overinvestment and excess capacity in similar industries targeting a limited global market. The balance of payments constrained growth model however emphasises that countries should produce goods which have a high and growing income elasticity of demand in world markets. This required strategic government intervention to, "pick the winners" (McCombie, 2012).

Palley (2002) further criticised the model for making developing countries dependent on the developed world's markets therefore making them vulnerable to external fluctuations and more successive to crisis. He also warned that competition between developing countries in a bid to gain competitive advantage has led to a "race to the bottom" which has been identified in the arenas of taxation, environmental regulation, wages and labour standards (Davies and Vadlamannati, 2011). Greater co-operation between developing countries has been identified as vital in overcoming the latter point.

Despite the criticism and the validity in some of the arguments, a strategic export-led growth model exploiting dynamic comparative advantage is described as the best development strategy for developing countries (McCombie, 2012). A strategy aimed solely at increasing domestic demand will be overhauled by the balance of payments constraint. An export-led growth strategy relaxes the balance of payments constraint, allowing countries to import more capital goods that are essential for development. Furthermore, it allows countries to benefit from economies of scale that would not have otherwise been possible. Greater competition increases efficiency as companies face domestic and foreign competition. In addition it facilitates the transfer of knowledge and has been linked to increased productivity.

7.3. The Balance of Payments Constraint and the Structure of Production

Regional integration offers massive potential for development by relaxing the demand constraint felt by the region. However the role of structural change in economic development cannot be ignored as seen by the large body of literature that has developed relating the two. As stated by Pasinetti (1993, p.9),

> *"Concepts such as 'big push' (Rosenstein-Rodan, 1943), 'unbalanced growth' (for example see Streeten, 1959), 'dual economies' (Lewis, 1954, Nurkse, 1953) and so on, are inevitably connected with some changes in the system's structure."*

The balance of payments constrained growth model too cannot escape the powerful bounds of economic structure. According to the model, growth is determined by the income elasticity of demand for exports multiplied by world income, εz, divided by the income elasticity of demand for imports π.

$$* y_B = \varepsilon z/\pi \quad \text{(Equation 2.44)}$$

The income elasticities reflect the structure of production (Thirlwall, 1997). A limitation of the above model is that it aggregates the export and income elasticities, when in practice, they are weighted averages of sectoral elasticities. This led to the development of the "multisectoral Thirlwall's law," (Araujo and Lima, 2007) which builds on the Structural Economics Dynamics (SED) approach developed by Pasinetti (1981). According to the model, a country can increase its growth rate, even in the absence of exogenous world growth, by changing the sectoral composition of exports and imports based on relative elasticities of demand (Gouvea and Lima, 2010).

Natural resource endowments and the types of goods produced resulting from historical incidents or developments mainly determine the income elasticities (Thirlwall, 1991). When analysing the sub-Saharan region, the importance of the colonial legacy for the latter cannot be ignored. Under such a system, the "metropolitan" country or imperial state had an interest in the dependent country as both an export and import market (Myrdal, 1957).

With regards to exports, it exploited local natural resources and the availability of cheap unskilled labour through the promotion of large scale primary goods production. In the case of imports, the removal of trade barriers ensured that the indigenous industries were outcompeted, thereby hindering their growth and rendering the dependent country a market for the metropolitan country's manufactured products (Smith, 1776; Myrdal, 1957).

Upon independence, former dependent countries "inherited" enclaves producing primary goods for exports and large subsistence economies which employed a large share of the population (Myrdal, 1957). This structure is likely to perpetuate itself as the foreign exchange for the import of capital equipment needed for development comes from export earnings.

7.3.1. Countries Specialising in the Production of Primary Products

It is generally accepted that primary commodities, which consists mainly of agricultural products and minerals[87], have an income elasticity of demand less than unity, as stated by Engles law, while many industrial products have an income elasticity of demand greater than unity[88]. The result of

[87] The definition for a primary commodity is, "a product of farm, forest, fishing and hunting or an extractive industry to whose value transformation has made only a minor contribution" (United Nations, 2002, p.8).
[88] A priori, we expect low income countries, who specialise in the production and export of primary products and light industries to have a low income elasticity of demand for exports (Thirlwall, 1997).

this relationship has best been explored in centre-periphery models. The centre specialises in the production of industrial goods while the periphery is mainly concerned with the production and export of primary products. The basis of these models is that the growth rate of the periphery relative to the centre is equal to the ratio of the income elasticity of demand for imports and exports**.** *If the real terms of trade between the two categories of goods remain unchanged, a balance of payments constraint will arise in the country producing and exporting primary products relative to the country producing and exporting industrial products (Thirlwall, 1991).*

As seen in chapter 3, since the early 2000s, the sub-Saharan region has experienced favourable terms of trade due to the commodity boom resulting from high world growth rates. This would have the effect of loosening the balance of payments constraint, allowing countries to grow faster. Following the global financial crisis, growth in the developed world has slowed, and although growth in China and India appeared resilient at first, their growth rates too have decelerated in recent years. This has been followed by a fall in commodity prices, with the largest hits taken by crude oil and metal prices which both saw a fall of over 50% between June 2014 and January 2015 (World Bank, 2015). This has significantly weakened the balance of payments position in countries like Angola, Chad, Equatorial Guinea and Nigeria whose oil exports account for roughly 90% of merchandise exports.

This outcome should have been expected as theoretically and empirically shown by Singer (1950) and Prebisch (1950), over time the terms of trade move against primary products in favour of manufactured products. A result mainly attributed to the unequal distribution of the gains from technological progress, which is known to be higher in industry. Countries specialising in the production of primary products would therefore continuously need to export more of their product for the same amount of manufactured goods. This would naturally worsen the balance of payments constraint on growth. *The only way countries heavily dependent on the production and export of primary products can partake in the gains from free trade is through industrialisation (Singer, 1950).*

7.4. Phases of Industrialisation

The economy can be seen to consist of three sectors, namely agriculture, industry and services. While neoclassical and new endogenous growth models are "sector indifferent," post-Keynesian and Latin American Structuralism theories are "sector specific" in the sense that the structure and dynamics of growth are crucially dependent on the sector being developed. Of great importance is the "size, strength and depth of the manufacturing sector," for this will affect a country's ability to embrace new technology and ultimately its ability to catch up with developed countries (Palma, 2014, p.21). “One of the main lessons of world economic history of the past two centuries is that sustained economic growth is achieved with sustained industrialisation” (DiJohn, 2011, p.167).

During the early phases of development, sectors are associated with productivity and wage gaps. Indeed, a mature economy is characterised by the elimination of sectoral differences in output per capita (Kaldor, 1967). Traditionally, the subsistence agricultural sector is associated with low productivity growth due to diminishing marginal returns typical with land based activities. There is most likely to be surplus labour disguised in the form of underemployment as depicted in the Lewis (1954) dual sector model. The same applies for services. Industry on the other hand is seen as a high productivity growth sector due to increasing returns. Economic development is now seen synonymously with a fall in the labour share of agricultural production with an increase in the share of industry and services (Timmer et al, 2012).

Although there are several growth models which shed light on the role of structural change and the industrial sector, our focus is on the Kaldorian model from which the balance of payments constrained growth model stems. Indeed, Thirlwall and Dixon (1979) by placing a balance of payments constraint on the Kaldorian export-led cumulative causation growth model found that under certain assumptions its growth rate reduced to the dynamic Harrod foreign trade multiplier result.

Kaldor (1967) distinguished four stages of industrialisation. The early stage is associated with a decrease in the import of manufactured goods alongside the increase in the import of machinery and equipment needed in the production of the former. Domestic manufacturing in this phase mainly consists of light industries. As the domestic consumption of these goods increases, the import substitution process is completed and the country enters the second stage when it gradually becomes a net exporter of manufactured consumer goods. The third stage of industrialisation involves the import substitution of capital goods. The final stage is associated with “explosive growth” as the country becomes a net exporter of capital goods. Growth at this stage is described as self-sustaining, for by the very process of supplying capital goods, demand for them is generated.

Kaldor’s (1967) model of economic development shares similarities with the Wild-Geese Flying Pattern model, in particular the emphasis on the role of import substitution, described by Akamatsu (1962, p.13) as recovering the home market from the hands of foreign industries as well as the need to gradually switch from the specialisation of “special goods” to the export of capital goods. This process implies the gradual upgrading of production of exports, captured in the balance of payments constrained growth model as the income elasticities of demand, determined by supply factors such as, “investment in new technology, research and development effort, education and training in skills, etc” (Thirlwall, 1998, p.187). According to Chang (2009, p.491), “it is simply not possible for a backward economy to accumulate capabilities in new industries without defying comparative advantage”.

There is a general consensus amongst development economists of the need for developing countries to “defy” their static comparative advantage (Lin and Chang, 2009). However of contention is the degree of deviation necessary for the further one diverges, the higher the price of acquiring capabilities in new industries. The process requires government intervention as it is unlikely to occur through market forces alone due to fundamental uncertainty and bounded rationality regarding the length of the learning process in acquiring new capabilities. This is the basis of the infant industry argument, which seeks to generate and protect start up industries while they develop new capabilities, until a point when they can compete with foreign firms. In fact, the gradual reduction in protection as the industry expands is described as vital for it introduces “moderate competition” which helps increase efficiency (List, 1856, p.388).

7.4.1. Reconciling the Theory with the Empirical Literature and Statistical Facts

According to Kaldor (1957), Verdoorn’s law as originally presented applied only to industry. This led to the development of Kaldor’s (1966) three growth laws. The first law holds that growth of GDP is positively related to growth in manufacturing output. This is true in a definitional sense as GDP consists of manufacturing output however, most vital here is the fundamental causal relationship due to the characteristics of manufacturing activities. The second law, also known as Verdoorn’s law explained above, argues that due to static and dynamic increasing returns to scale, growth in labour productivity in manufacturing is positively related to manufacturing output growth. The third law holds that due to diminishing returns in the agriculture and service sector, there is a negative relationship between growth of employment in the non-manufacturing sector and labour productivity growth in the economy.

Kaldor’s (1966) three growth laws were first tested by Wells and Thirlwall (2003) for 45 African countries for the 1980 to 1996 period. They observed that the industrialisation process appeared to have “bypassed” Africa as there had been no structural change in Africa in the two decades analysed. Their results however provided evidence in favour of all three of Kaldor’s growth laws and the authors conclude that structural change in favour of industrialisation would, “almost certainly help to accelerate the growth of GDP and living standards in Africa" (Wells and Thirlwall, 2003, p.89).

More recently, Pacheco-Lopez and Thirlwall (2013) tested Kaldor's first growth law, modifying it to an open economy. Using data for 89 developing countries for the 1990 to 2011 period, their results confirm those of Hausmann et al (2007) that what a country exports matters. Those producing manufactured goods with a high income elasticity of demand in world markets have a higher growth of exports and GDP.

It is acknowledged that not all structural change is beneficial. It can be growth enhancing or growth reducing. The structural change that has taken place in Africa since the 1990s was found to be growth reducing as labour moved from high productivity sectors to low productivity sectors (McMillan and Rodrik, 2011). This result follows liberalisation policies that swept across the region following the late 1980s debt crisis. Liberalisation however cannot be blamed for the growth reducing structural change that took place in the sub-Saharan region for it did not take place across all countries. For instance East Asian countries experienced growth enhancing structural change during the same period analysed as rapid export growth was accompanied by an expansion of industrial capacity and upgrading (Shafaeddin, 2005).

The speed at which liberalisation reforms are implemented and the level of development have been identified as important factors for the direction in which structural change will take place (Shafaeddin, 2005). An economy's activities prior to liberalisation can be categorised into four groups. The first group are already competitive internationally due to well-developed capabilities and resource advantages. The second group consists of industries that are close to maturity. Liberalisation will benefit these two groups as it increases efficiency, particularly in the latter, thus further boosting international competitiveness. There is empirical evidence suggesting that, following trade liberalisation, the industries able to thrive in the developing world belonged to the first two groups (Shafaeddin, 2005).

The third group is characterised by infant industries which are still in the learning by doing phase and the final group consists of activities that are not economically viable, currently and potentially. Liberalisation would therefore hurt the third and fourth group as they are unable to compete internationally (Lall et al, 1994; Shafaeddin, 2005). These differences in economic activities therefore require slow and selective liberalisation, as carried out in East Asia (Shafaeddin, 2005).

Following independence, many African states embarked on a period of import substitution industrialisation aimed at upgrading and expanding their productive capacities. A blanket approach was often taken when implementing protectionist policies. As a result, at the time of liberalisation in the 1980s, many of these protected industries fell within the third and fourth category, i.e. they were still in their infant stage or unviable. The labour displaced as these firms exited the market[89], failed to find employment in the formal economy due to a lack of adequate formal employment creation.

Growth in formal employment has been low as Africa's static comparative advantage is in the production of agricultural products and minerals. While the extractive industries are capital intensive, they offer limited employment opportunities (McMillan and Rodrik, 2011). They also offer very limited spread effects (Myrdal, 1957) as well as limited backward and forward linkages (Hirschman, 1984). Displaced labour therefore ends up employed in the informal sector which is known to have lower productivity levels than the formal agricultural sector due to high levels of underemployment.

The situation was compounded, for the expansion of extractive industries led to cases of Dutch disease, originally described as, "the appreciation of the real exchange rate arising from a boom in commodity exports," (Palma, 2014, p.14) resulting in a relative price change favouring non-traded goods against traded goods, thus decreasing competitiveness in the latter (DiJohn, 2011). The term "disease" implies that, a unit value added in manufacturing is superior to that added from other sectors (Palma, 2014; DiJohn, 2011). The process has been used to partially explain the "premature deindustrialisation" that has taken place across the continent.

Despite the negative consequences arising from the discovery or specialisation in natural resources, often referred to as the resource curse[90], Neary and Wijnbergen (1985) theoretically showed that it does not "inevitably" lead to deindustrialisation. Sectors exposed to foreign competition in markets where they are price takers are expected to decline. Industries that cater to the domestic market due to trade protection, or which have some degree of monopolistic price setting power in export markets, may benefit and possibly expand. From the latter it is clear that the outcome to some degree depends on state policy responses (DiJohn, 2011).

The role of regional integration, with a focus on industrial policy aimed at defying, to a limited extent, comparative advantage in order to upgrade and expand productive capacity is a powerful tool for development. The sub-Saharan region consists of a diverse range of countries, with different levels of technological capabilities. Closer regional integration, which encourages the

[89] This may also include those displaced from the second group which experienced massive increases in efficiency as they faced global competition (McMillan and Rodrik, 2011).
[90] Historically, the presence of natural resources were a source of economic development, not hindrance.

sharing of information and knowledge, has massive potential for positive spill over effects. In addition, it allows for higher productivity growth in the industrial sector as access to a larger protected market will allow the further division of labour resulting in economies of scale that would have been impossible (Smith, 1776).

"By joining hands and pooling what they have of bargaining power, the underdeveloped countries can together gain for themselves consideration which they could not have got individually" (Myrdal, 1957, p.69). This is specifically true in relation to trade negotiations with the rest of the world. *Most of the countries in the region are relatively small, specialising in the production and export of similar products. By coming together, they can increase their chance of securing more favourable trade deals which grant them access to foreign markets for their exports while allowing them to pursue protectionist policies to protect infant industries.*

7.5. Financing Development and Structural Change

As mentioned in the previous sections, structural change requires capital investment as well as investment in learning new capabilities. This section outlines the possible sources of finance that the region could tap into.

According to the neoliberal view, financial development is a source of comparative advantage as it increases exports in sectors that depend on external finance (Beck, 2001). Technology is assumed to automatically diffuse across sectors and countries. There is however, some evidence that liberalised financial markets are inclined to not provide financing for structural change that moves away from static comparative advantage.

A study by Ebireri and Paloni (2014), found that *liberalisation of the financial sector leads to the concentration of exports in areas where a country has existing comparative advantage*. This is essentially due to fundamental uncertainty associated with adopting new technologies requiring tacit knowledge as well as "tinkering" to local conditions. Banks are therefore unwilling to finance the learning process during which firms may make large losses. Finance is therefore more likely to be received by low value added sectors producing products that are already competitive internationally and employing low technology.

According to Hausmann et al (2007) *improving the functioning of financial markets would not stimulate entrepreneurial activity* as, "innovation is undercut by lack of demand from its potential users… in turn, the demand for innovation is low because entrepreneurs perceive new activities to be of low profitability" (Timmer et al, 2012, p.8). Market failures related to "cost discovery" hamper entrepreneurs in the developing world from taking on the production of new products. This is due to costs linked to exploring the economy's underlying cost structure. For instance, an entrepreneur first needs to determine if a new investment or production technique will be profitable under local production conditions. If the new venture fails, the entrepreneur is solely burdened with the losses however where successful, other entrepreneurs soon emulate the activity. The process is therefore associated with large positive externalities for other entrepreneurs. Unless this externality can be internalised, demand for such activities will remain deficient (Hausmann et al, 2007). This view can be described as Keynesian, which like Schumpeterian models, sees dynamic entrepreneurs willing to take risks as "crucial to the investment decision" (Thirlwall, 1985, p.15).

It is clear that there is a "positive complementary" role for public development banks to provide financing for new activities that have some degree of fundamental uncertainty (United Nations, 2015). The complications outlined above reiterate the need for strong development banks coupled with a clear, selective and decisive industrial policy aimed at structural transformation. Other roles include encouraging investment through counter-cyclical finance, mobilising broader financial resources and financing public goods. Development banks which can take the form of national, regional or multinational can compensate for some of the limitations outlined in the private financial sector.

The results from the balance of payments constrained analysis provides empirical evidence that although the sub-Saharan region was balance of payments constrained, financial inflows helped to alleviate the constraint. However, also imperative were interest payments abroad, which added a further constraint to growth. According to Elliott and Rhodd (1999, p.1148), these payments "rob the economy of much needed resources to promote economic growth". The significance of debt accumulation and interest payments abroad were most pronounced in the 1980 to 2014 sub-period.

African countries will need to better mobilise domestic resources to meet future development goals. This comes after a drop in 2011, for the first time in a decade, of official development assistance to low income countries, as donor countries continue to tighten aid budgets following below average economic performance (World Bank, 2013b). One source that offers massive potential is curbing illicit financial flows.

Illicit financial flows, are defined as "money illegally earned, transferred or used" (African Union Commission/United Nations Economic Commission for Africa, 2011), in its origin, movement or use (Kar and Cartwright-Smith, 2010)[91]. For the 39 year period starting in 1970, sub-Saharan

[91] Illicit financial flows should not be confused with capital flight. Not all capital flight is illicit (African Union Commission/United Nations Economic Commission for Africa, 2011).

Africa lost between USD814 billion and USD1.8 trillion in illicit financial flows (Kar and Cartwright-Smith, 2010; Boyce and Ndikumana, 2012). Due to data limitations, the former is significantly underestimated and the true loss believed to be closer to the latter. This exceeds the combined total of official development assistance and foreign direct investment (Boyce and Ndikumana, 2012).

Accounting for 65% of these flows were commercial activities aimed at the illegal export of foreign exchange and tax evasion and avoidance (Baker, 2005; African Union Commission/United Nations Economic Commission for Africa, 2011; Reuter, 2012). Activities include trade mispricing, “abusive” transfer pricing and misinvoicing of services and intangibles. Criminal activities accounted for 30% and consists of people trafficking, the smuggling of drugs and arms and financial sector fraud. The remaining 5% of flows are a result of corruption, however its role in facilitating other forms of illicit financial flows is acknowledged (African Union Commission/United Nations Economic Commission for Africa, 2011).

The discussion on illicit financial flows is not inconsistent with the balance of payments constrained growth model. The fact that 65% of illicit flows happen through commercial activities that tend to under-price exports and overprice imports, reinforces the idea that the countries in question were balance of payments constrained. Tackling the problem, will generate more funds that can be used to import the capital goods needed for development as well as finance new sectors that “defy” static comparative advantage. Regional integration can offer a platform for a uniform policy on tackling illicit flows. It may in addition give African nations a larger voice in the international community as the above mentioned problem is global, affecting both developed and developing nations.

7.6. Concluding Remarks

The balance of payments constrained growth model provides support for the export-led growth literature, itself originating from the Kaldorian export-led model (Thirlwall and Dixon, 1979). Under the “weak” version, where international prices are constant, growth can be improved by increasing exports, which can be described as the only source of autonomous demand, with large multiplier effects on the economy as a whole. However, as seen in the “strong” version of the model, the income elasticity of demand for exports is important, and partly explains growth rate differences between countries.

Emphasis is additionally placed on the income elasticity of demand for imports. The type of products a country exports matters however the type of products a country imports also matters for growth. The sub-Saharan African countries should therefore promote structural change in favour of producing products that have a high income elasticity of demand in world markets. At the moment, the majority of countries in the region specialise in the production and export of primary products while imports consist of manufactured and capital goods. It is widely accepted that manufactured products have a higher income elasticities of demand than primary products. This point is often emphasised by centre-periphery models (Singer, 1950).

Upgrading industrial capacity from the production of primary products to manufactured products, requires industrial policy geared towards, "defying comparative advantage". This process could best be achieved through stronger regional integration as countries have different levels of production capabilities offering great potential for positive spill over effects through knowledge sharing. The move to the production of manufactured products inevitably leads to an increase in the import of capital goods and equipment. Regional integration expands the possibilities open to the region, for countries with relatively high capabilities, could be ready to enter the third stage of industrialisation involving import substitution of capital good (Kaldor, 1966). Growth in demand for these products in the region as many switch to manufacturing, may further stimulate, speed up and enhance productivity for the firms in question. We could not emphasise enough,

> *"The perfection of manufacturing industry, it must be remembered, depends altogether upon the division of labour; and the degree to which the division of labour can be introduced into any manufacture, is necessarily regulated, it has already been shewn, by the extent of the market" (Smith,1776, p.555).*

Regional integration will in addition provide the sub-Saharan region, which is mainly made up of small countries often producing and exporting the same sort of products, more bargaining power when negotiating with the rest of the world. This is particularly true for trade deals, which need to grant the region access to global markets for their exports, while at the same time, allow them to implement selective protectionist policies aimed at protecting infant industries. A stronger voice globally, will also help the region address the problem of illicit financial flows, which could be used to finance development.

Chapter 8

8. CONCLUSION

The research contributes towards understanding the importance of demand and the balance of payments constraint for low income economies, with specific reference to sub-Saharan Africa. This is achieved by addressing four research sub-questions outlined in the introduction. Understanding the relevance of Keynesian economics for sub-Saharan Africa is important as the latter offers an alternative set of policies for long run sustainable growth and development, emphasising the role of demand in stimulating economic activity. In addition, it recognises industry, in particular the manufacturing sector, as the leading sector due to increasing returns to scale (Kaldor, 1966).

As discussed in chapter 2, neoclassical economics and international trade models based on comparative advantage have dominated economic policies in the region. Unfortunately, these policies have failed to deliver long run sustainable growth for they have left the region specialising in the production of primary products and increased their vulnerability to external fluctuations and crisis (Easterly, 2003).

The starting point of the empirical analysis is to address our first research sub-question related to the endogeneity of the natural rate of growth. According to Leon-Ledesma and Thirlwall (2002), if the natural rate of growth is endogenous to the actual rate of growth, demand matters for long run growth.

The natural rate of growth was first introduced by Harrod (1939) alongside the actual rate of growth and the warranted rate of growth. The debate surrounding the adjustment mechanism that reconciles the natural rate and the warranted rate of growth for long run growth has taken centre stage. In the supply-led neoclassical growth literature, the natural rate of growth is taken as exogenous (Solow, 1956) however in the demand-led post-Keynesian literature, the latter is treated as endogenous (Leon-Ledesma and Thirlwall, 2002). No empirical studies on the adjustment mechanism have been carried out for the sub-Saharan African region or for low income economies in general where demand was assumed by neoclassical economists, to be irrelevant for long term growth (Dasgupta, 1954).

The empirical results presented in chapter 4 provide strong and robust evidence across different estimation techniques that the natural rate of growth is endogenous to demand changes for the sub-Saharan African region. 31 countries based on data availability for the 1991 to 2012 period were included in the analysis. In order to overcome the limitation resulting from the short time span of the data, both time series and panel data estimation techniques were applied. In addition we made use of an instrumental variable approach to address the problems associated with the endogeneity of the unemployment rate. The results provide strong evidence that the natural rate of growth is endogenous to the actual rate of growth.

Applying a political economy and institutionalist approach to the post-Keynesian theory, our results indicate that low income economies are most responsive to demand changes in the boom period. The sensitivity in the natural rate of growth is negatively correlated with the level of economic development and key institutional indicators such as voice and accountability, government effectiveness, regulatory quality and the rule of law. This may be due to the negative effect that political instability and poor institutional quality has on investment and growth, thus mediating the effect of demand on the natural rate of growth in boom periods. Other factors such as the relatively large size of the informal sector, low levels of productivity and the specialisation in labour intensive industries (Dray and Thirlwall, 2011), aid in explaining the higher responsiveness in the natural rate of growth to demand changes in low income economies.

The results from our analysis, that the natural rate of growth is endogenous to the actual growth rate are vital for they provide support for Thirlwall's (2001) claim that the former cannot be the long run constraint to growth for within limits, it adjusts to changes in demand. In the post-Keynesian literature, in an open economy, the main constraint to long run growth is the balance of payments equilibrium growth rate (Thirlwall and Dixon, 1979; Thirlwall, 2001; Blecker, 2009; Lanzafame, 2014). In light of the results in chapter 4 indicating the endogeneity of the natural rate of growth and the relevance of demand for growth, we address our second research sub-question by empirically testing the demand-led balance of payments constrained growth model.

Previous research has found support for the balance of payments constrained growth model for the sub-Saharan African region with data covering the 1970 to mid-1990s period (Hussain, 1999; Perraton, 2003). However the most comprehensive model modified to account for sustainable debt accumulation and interest payments abroad has not been empirically tested (Moreno-Brid, 2003). Applying this model to the region is crucial as the majority of the respective countries are heavily indebted (World Bank, 2015). In chapter 5 we test six different balance of payments constrained growth models for 22 countries with data covering the 1960 to 2014 period. An ARDL model is used to estimate the export and import demand functions, taking into consideration significant structural breaks in the data.

When formally testing the validity of the model for individual countries, the balance of payments constrained growth model with sustainable debt accumulation and interest payments abroad explained the growth experience of 77% of the countries included in the analysis. Hence it outperformed all other versions of the model. It would therefore be erroneous to dismiss the balance of payments constrained growth model for the region without applying the extended model which accounts for sustainable debt accumulation and interest payments abroad. Our results from the two sub-periods further indicate that debt and interest payments abroad were not significant in the 1960 to 1980 period. However they were significant for the 1980 to 2014 sub-period and the overall 1960 to 2014 period thus highlighting the growing importance of debt and interest payments abroad since the 1980s.

The results from the individual country tests show that Benin, Chad, Botswana and Namibia were not balance of payments constrained. This is not surprising as Botswana and Namibia both persistently ran a current account surplus while Chad experienced extreme fluctuations between surplus and deficit. However, the cross country tests provide strong evidence that overall the sub-Saharan African region was balance of payments constrained during the period concerned.

In the long run, growth in potential output should equal growth in demand. We therefore address our third research sub-question by analysing the relationship between the natural rate of growth and the balance of payments constrained growth rate within a panel VAR model. As our main interest is in the long run relationship, we apply a 4 year average to smooth out short term fluctuations.

Granger causality analysis provides evidence of unidirectional causality running from the balance of payments constrained growth rate to the natural rate of growth. This result is consistent with the endogeneity of the natural rate of growth as well as the theoretical expectations of Thirlwall (2001) that in an open economy, the main constraint to growth is the balance of payments equilibrium growth rate. This provides further support to Setterfield's (2006) claim that adjustment to the steady state takes place through the Verdoorn coefficient, which relates growth in productivity to growth in output. The results make a significant contribution to the literature as no other studies analyse the adjustment mechanism that reconciles the natural rate of growth and the balance of payments constrained growth rate for sub-Saharan Africa or low income economies in general.

Within the balance of payments constrained growth framework, growth rate differences between countries can be explained through differences in the income elasticities of demand for exports and imports respectively. These elasticities in turn are determined by the structure of economic activity. It is widely accepted in the heterodox literature that manufactured products have a higher income elasticity of demand than primary products. As the sub-Saharan African region specialises in the production and export of primary products, chapter 7 addressed the fourth research sub-question related to how structural transformation can be achieved for sustainable growth and development.

Structural transformation in favour of industry and services after a certain level of income per capita is achieved, has become synonymous with economic development (Timmer et al, 2012). However the industrialisation process is described as having "bypassed" Africa (Wells and Thirlwall, 2003). In the post-Keynesian literature, industry is the leading sector as it is characterised by increasing returns to scale (Kaldor, 1966). Due to market failures related to fundamental uncertainty and bounded rationality, growth enhancing structural transformation along Kaldorian lines may not automatically occur (Ebireri and Paloni, 2014). The role of the state in facilitating structural transformation is therefore vital. Closer regional integration between sub-Saharan countries, by increasing the size of the market, could alleviate the demand constraint to growth by increasing the number of profitable investment opportunities.

By "defying" their static comparative advantage in producing primary products, sub-Saharan Africa can gain new capabilities in the production of manufactured goods associated with higher income elasticities of demand in world markets. In addition, growth can be enhanced by reducing the income elasticity of demand for imports.

There are some key limitations to the research. Firstly, data on unemployment does not distinguish between those employed in the formal and informal sector. This is due to poor data availability on the region. Future research as more data becomes available could distinguish between the type and quality of employment.

Although we informally address the issue of illicit financial flows in chapter 7, we do not formally account for them. Future research extending the balance of payments constrained growth model to include illicit financial flows would shed further light on the constraints to growth faced by the region and developing countries in general.

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Appendix A

Data and sources for calculating the natural rate of growth

Variable	Source
GDP growth (constant 2005 USD)	World Development Indicators (World Bank)
Total unemployment (% of total labour force)	World Development Indicators (World Bank)

Descriptive statistics used for estimating the natural rate of growth

	Unemployment rate				GDP growth				
Country	Mean	Standard dev.	Min	Max	Mean	Geometric mean	Standard dev.	Min	Max
Angola	7.532	0.178	7.3	8.1	6.336	7.181	9.878	-24.7	22.593
Botswana	21.16	2.270	17.6	25	4.499	3.959	3.854	-7.841	9.667
Burkina Faso	2.782	0.402	2.3	3.3	5.781	4.667	2.804	0.233	11.015
Burundi	7.927	0.128	7.7	8.1	1.046	3.399	4.344	-8	5.385
Cameroon	5.341	1.426	3.4	8.1	2.571	3.723	2.888	-3.809	5.100
Central African Rep.	7.636	0.079	7.5	7.8	3.161	4.253	4.473	-6.424	8.907
Chad	7.677	0.134	7.3	7.9	6.591	4.973	9.195	-15.71	33.629
Congo, Dem. Rep.	7.291	0.102	7.2	7.5	0.391	4.818	6.537	-13.47	7.801
Congo, Rep.	7.222	0.134	7	7.5	3.137	4.165	3.646	-5.493	8.752
Equatorial Guinea	7.105	0.473	5.8	7.7	17.37	11.718	20.293	-2.966	71.188
Ethiopia	6.682	1.154	5.4	8.2	6.244	7.704	6.653	-8.673	13.572
Gabon	19.2	0.799	17.8	20.6	2.301	3.422	3.879	-8.933	7.1
Gambia	7.832	0.078	7.7	8	3.319	3.329	3.242	-4.295	7.05
Ghana	6.086	2.678	3.2	10.4	5.656	5.287	2.540	3.3	15.007
Kenya	9.691	0.284	9.2	10.2	3.156	2.489	2.186	-0.799	6.993
Malawi	7.55	0.213	7.2	7.9	3.307	4.676	6.587	-10.24	16.729
Mali	8.441	0.219	8.1	8.9	4.695	4.542	3.223	-2.139	12.1
Mauritius	8.368	0.835	6.8	9.6	4.469	4.116	1.741	1.241	9.026
Mozambique	7.682	0.199	7.5	8.2	6.741	6.675	3.568	-5.105	11.899
Namibia	21.12	4.402	16.7	37.6	4.503	4.569	3.062	-2.008	12.272
Nigeria	7.545	0.091	7.4	7.7	5.546	3.971	6.965	-0.618	33.735
Senegal	9.959	0.059	9.9	10.1	3.533	3.184	1.945	-0.017	6.683
Sierra Leone	3.4	0.044	3.3	3.5	2.969	5.054	8.874	-19.01	26.268
South Africa	23.89	2.392	16.9	27.2	2.724	3.047	2.143	-2.137	5.603
Sudan	15.03	0.225	14.8	15.6	4.811	5.263	4.662	-10.1	11.515
Swaziland	22.62	0.333	21.7	23	2.328	2.232	1.311	-1.5	4.825
Tanzania	3.741	0.935	2	5.1	5.158	4.385	2.257	0.584	7.828
Togo	7.845	0.140	7.6	8.2	2.630	4.335	6.242	-15.09	14.982
Uganda	2.854	0.756	2	4.2	6.822	6.448	2.244	3.142	11.523
Zambia	15.48	2.312	12	19.7	3.544	5.213	4.147	-8.625	7.620
Zimbabwe	5.154	0.969	4	6.9	-0.51	3.428	8.043	-17.67	10.551

Data and sources for calculating the balance of payments constrained growth rate

Variable	Source
Exports of goods and services (constant 2005 USD)	World Development Indicators (World Bank)
Imports of goods and services (constant 2005 USD)	World Development Indicators (World Bank)
GDP (constant 2005 USD)	World Development Indicators (World Bank)
GDP deflator (base year 2005)	World Development Indicators (World Bank)
Consumer price index (CPI)	World Development Indicators (World Bank)
World Income, less own country income (constant 2005 USD)	World Development Indicators (World Bank)
Export price index (unit value of exports, f.o.b) (Base year 2005)	International Financial Statistics (IMF)
Import price index (unit value of imports, f.o.b) (Base year 2005)	International Financial Statistics (IMF)
Interest payment on external debt (constant 2005 USD)	World Development Indicators (World Bank)
REER (Real effective exchange rate, CPI-based)	REER database (Bruegel)

REER measures the development of the real value of a country's currency against the basket of the trading partners of the country. It therefore can be expressed as Pd/Pf or Pd/Pm which is domestic to foreign prices.

We use REER to estimate the import and export demand functions. In the export demand function, we make use of the domestic to foreign price ratio, Pd/Pm. REER is therefore used in the export demand function. For the import demand function, we make use of the foreign to domestic price ratio, Pf/Pd, 1/REER is therefore used in the import demand function.

Other price indices were also used when REER was not available. We use the price index recommended by Tharnpanich and McCombie (2013).

$$RPM2 = \frac{Import\ price\ index}{GDP\ deflator}$$

$$RPM3 = \frac{Import\ price\ index}{CPI}$$

$$RPM4 = \frac{Import\ price\ index}{Export\ price\ index}$$

$$RPX4 = \frac{Export\ price\ index}{import\ price\ index}$$

Data and sources for calculating Granger causality analysis

Variable	Construction	Source
Exports of goods and services (constant 2005 USD)		World Development Indicators (World Bank)
GDP per person employed (constant 2011 PPP USD)		World Development Indicators (World Bank)
Total labour force		World Development Indicators (World Bank)
Labour force in efficiency units (lfe)	Sum of growth in persons employed and growth in total labour force	
GDP growth		World Development Indicators (World Bank)
Unemployment rate		World Development Indicators (World Bank)

Descriptive statistics for data used in Granger causality analysis

		Annual data				4 year average			
	Period	Mean	Standard dev.	Min	Max	Mean	Standard dev.	Min	Max
Growth in exports, x	1991-2014	5.558	16.480	-54.04	101.78	5.457	8.558	-23.127	34.242
Unemployment rate	1991-2014	10.763	6.876	0.7	37.6	10.837	6.919	0.82	26.1
Labour force in efficiency units, lfe	1991-2014	3.774	5.144	-21.46	29.276	5.457	8.558	-7.758	12.318

Appendix B

The results from the unit root tests are shown below. Included are the Clemente, Montanes and Reyes (CMR) unit root test where,

- Sudden changes in the series are captured by the Additive Outliers (AO)
- Gradual shift in the mean of the series is detected by the Innovational Outliers (IO)

Results from the unit root tests

Country	Variable	CMR2 (AO)	Breaks	CMR1 (AO)	Break	CMR2 (IO)	Breaks	CMR1 (IO)	Break	ADF^{N}	ADF NC	ADF trend	PP	PP NC	PP trend
Angola	ΔU									-4.630***			-4.696***		
	g	-2.818	2003*** 2008***					-5.135***		-2.325	1.799*	-2.478	-2.293	-1.789*	-2.526
Botswana	ΔU									-5.346***			-5.808***		
	g									-5.367***			-5.650***		
Burkina Faso	ΔU									-8.181***			-8.762***		
	g									-4.995***			-4.982***		
Burundi	ΔU									-3.310**			-3.246**		
	g			-4.354***	1998***	-5.838**	1996*** 2004**			-2.320			-2.377		
Cameroon	ΔU									-6.754***			-7.050***		
	g			-2.572	1996***	-8.902***	1993*** 2004**			-2.355	-0.788	-1.923	-2.349	-0.963	-1.936
Central African Rep.	ΔU									-7.931***			-8.520***		
	g									-3.979***			-3.951***		
Chad	ΔU									-6.152***			-6.722***		
	g									-3.568***			-3.571***		
Congo, Dem. Rep.	ΔU									-5.479***			-5.666***		
	g			1.906	2002**	-6.108***	1992*** 2001***			-1.445	-1.437	-2.576	-1.344	-1.399	-2.604
Congo, Rep.	ΔU									-5.732***			-6.325***		
	g									-4.021***			-4.013***		
Equatorial Guinea	ΔU									-5.919***			-6.314***		
	g									-3.504***			-3.543***		
Ethiopia	ΔU									-2.871**			-2.857**		
	g									-3.712***			-3.737***		
Gabon	ΔU									-4.018***			-3.907***		
	g									-3.922***			-3.929***		

Gambia	ΔU									-6.120***			-6.905***		
	g									-5.011***			-5.121***		
Ghana	ΔU									-6.627***			-7.053***		
	g									-2.605*	-0.756	-4.27***	-2.517	-0.342	-4.280***
Kenya	ΔU									-8.316***			-9.339***		
	g									-2.825**	-1.197	-3.635**	-2.730*	-0.929	-3.606**
Malawi	ΔU									-8.795***			-8.670***		
	g									-6.631***			-6.5428**		
Mali	ΔU									-5.280***			-5.40***		
	g									-5.024***			-5.014***		
Mauritius	ΔU									-3.081**			-3.067**		
	g									-5.258***			-5.328***		
Mozambique	ΔU									-9.643***			-11.489***		
	g									-4.507***			-4.540***		
Namibia	ΔU									-5.394***			-5.522***		
	g									-5.663***			-5.758***		
Nigeria	ΔU									-6.815***			-6.563***		
	g									-3.678***			-3.668***		
Senegal	ΔU									-5.752***			-6.109***		
	g									-4.082***			-4.909***		
Sierra Leone	ΔU									-4.243***			-4.283***		
	g									-3.846***			-3.922***		
South Africa	ΔU									-3.885***			-3.855***		
	g									-2.966**			-2.895**		
Sudan	ΔU									-7.589***			-8.340***		
	g			-4.80***	2009***			-3.050	2009***	-0.662	-1.204	-0.951	-0.623	-1.182	-0.861
Swaziland	ΔU									-3.300**			-3.224**		
	g			-3.105	2009***			-3.691		-0.743	-0.912	-1.828	-0.684	-0.860	-1.812
	Δg									-4.536***			-4.551***		
Tanzania	ΔU									-6.349***			-6.393***		
	g	-4.032	1992** 1999***			-5.588**	1993*** 1999***			-1.293	0.519	-1.584	-1.233	0.621	-1.573
Togo	ΔU									-7.171***			-8.079***		
	g									-4.039***			-4.022***		
Uganda	ΔU									-2.453	-2.46**	-2.445	-2.546*	-2.56**	-2.553
	g									-3.694***			-3.668***		
Zambia	ΔU									-3.623***			-3.686***		
	g									-3.315**			-3.253**		
Zimbabwe	ΔU									-3.679***			-3.659***		
	g									-3.112**			-3.146**		

Note: The ADF unit root test uses one lagged value as determined by the presence of autocorrelation unless otherwise stated.
5% critical value for the CMR2 is -5.490
5% critical value for CMR1 is -3.560

5% critical value for ADF is -2.928
5% critical value for ADF no constant -1.950
5% critical value for ADF trend -3.497
5% critical value for PP is -2.927
5% critical value for PP trend -3.496
5% critical value for PP no constant -1.950
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Appendix C

Results from the Wald test based on SUR estimations from Equation 4.2

Group	Country	Wald test (P value)
1	South Africa and Swaziland	0.652
2	Zimbabwe, Zambia, Namibia and Botswana	0.870
3	Angola, Mozambique and Congo, Dem. Rep.	0.1736
4	Uganda and Ethiopia	0.5886
5	Chad and Central African Rep.	0.183
6	Cameroon and Gabon	0.699
7	Nigeria and Togo	0.531
8	Ghana and Burkina Faso	0.241
9	Sierra Leon, Gambia and Senegal	0.330
10	Malawi, Kenya and Congo, Rep.	0.089*
11	Tanzania, Ghana and Mali	0.461

Note: Wald test is used to test if the constant and the coefficient on %ΔU are not statistically different from each other.

Appendix D
Results from other studies

Leon-Ledesma and Thirlwall (2002)

Country	Thirlwall specification	Natural rate in boom periods	Absolute difference	% increase
Australia	3.999	5.713	1.714	42.861
Austria	3.136	4.956	1.82	58.036
Belgium	3.524	4.91	1.386	39.330
Canada	3.835	5.261	1.426	37.184
Denmark	2.942	4.782	1.84	62.542
France	2.827	3.934	1.107	39.158
Germany	3.505	4.709	1.204	34.351
Greece	4.509	7.671	3.162	70.126
Italy	3.344	5.91	2.566	76.734
Japan	4.567	8.719	4.152	90.913
Netherlands	3.282	5.315	2.033	61.944
Norway	3.972	5.009	1.037	26.108
Spain	4.062	6.092	2.03	49.975
UK	2.544	3.802	1.258	49.450
USA	2.991	3.664	0.673	22.501
Total	53.039	80.447	27.408	761.214
Average	3.536	5.363	1.827	50.748

Vogel (2007)

Country	Thirlwall specification	Natural rate in boom periods	Absolute difference	% increase
Argentina	3.03	7.2	4.17	137.624
Bolivia	3.03	4.42	1.39	45.875
Chile	6.12	7.91	1.79	29.248
Colombia	3.82	5.21	1.39	36.387
Costa Rica	4.77	6.81	2.04	42.767
Mexico	2.64	4.66	2.02	76.515
Nicaragua	2.64	5	2.36	89.394
Paraguay	2.64	4.54	1.9	71.970
Peru	5.13	7.96	2.83	55.166
Venezuela	1.78	4.62	2.84	159.551
Brazil	3.03	4.42	1.39	45.875
Total	38.63	62.75	24.12	790.371
Average	3.512	5.705	2.193	71.852

Libanio (2009)

Country	Thirlwall specification	Natural rate in boom periods	Absolute difference	% increase
Argentina	2.25	5.51	3.26	144.889
Chile	4.42	5.47	1.05	23.756
Colombia	3.34	4.31	0.97	29.042
Costa Rica	3.76	4.86	1.1	29.255
Mexico	2.57	4.38	1.81	70.428
Peru	2.13	4.67	2.54	119.249
Venezuela	2.36	3.11	0.75	31.780
Brazil	2.25	5.51	3.26	144.889
Ecuador	2.38	3.8	1.42	59.664
Uruguay	1.81	3.8	1.99	109.945
Total	27.27	45.42	18.15	762.896
Average	2.727	4.542	1.815	76.290

Dray and Thirlwall (2011)

Country	Thirlwall specification	Natural rate in boom periods	Absolute difference	% increase
China	10.36	12.04	1.68	16.216
Hong Kong	5.53	7.51	1.98	35.805
Indonesia	6.07	7.78	1.71	28.171
Japan	3.94	6.55	2.61	66.244
Singapore	7.66	9	1.34	17.493
South Korea	6.82	7.55	0.73	10.704
Sir Lanka	4.43	5.6	1.17	26.411
Taiwan	6.4	8.22	1.82	28.438
Thailand	6.72	9.55	2.83	42.113
Total	57.93	73.8	15.87	271.595
Average	6.437	8.2	1.763	30.177

Appendix E

Results from TSLS with the lags of %ΔU as instruments based on Equation 4.2

Country	Constant	%ΔU	R^2	F test	Natural rate of growth	lags	Durbin score[N]	Wu-Hausman[N]	F test from first stage regression[N]	Sargan score LM test[N]
Angola	10.798*** (3.292)	54.94 (53.94)		1.04	10.798***	2	5.581**	6.654**	0.883	0.095
Botswana	5.239*** (0.676)	-0.154 (1.225)	0.559	10.05***	5.239***	2			0.917	8.682***
Burkina Faso	5.897*** (0.593)	-0.061 (2.451)	0.006	0	5.897***	1	1.033	0.925	8.785***	
Burundi	0.253 (0.632)	-119.266 (74.912)		2.53	0.253	2	0.415	0.357	0.792	4.857**
Cameroon	3.318*** (0.615)	-1.212 (1.332)		0.74	3.318***	3	2.972*	2.768	0.467	0.676
Central African Rep.	3.853*** (0.972)	2.759 (17.392)		0.03	3.853***	1	4.152**	4.454**	7.92**	
Chad	7.477*** (2.469)	21.096 (30.828)		0.47	7.477***	2	5.731**	6.911**	2.503	0.009
Congo, Dem. Rep.	5.355*** (0.717)	-21.652 (22.58)	0.795	32.79***	5.355***	2	0.658	0.538	0.917	1.604
Congo, Rep.	3.402** (1.313)	20.157 (44.791)		0.2	3.402**	1	5.298**	6.126**	1.679	
Equatorial Guinea	17.419*** (4.158)	-16.686 (19.782)	0.435	5.35**	17.419***	2	0	0	3.467*	0.158
Ethiopia	7.795*** (1.408)	6.215 (7.95)		0.61	7.795***	2	0.896	0.792	1.921	1.431

Gabon	2.998*** (0.807)	-0.515 (2.879)	0.503	7.96***	2.998***	2	0.116	0.092	4.812**	1.502
Gambia	3.384*** (0.971)	11.439 (24.62)	0.298	0.22	3.384***	1	5.258**	6.063**	3.469*	
Ghana	5.436*** (0.450)	0.421 (0.355)	0.583	13.77***	5.436***	2	2.231	1.995	2.786*	0.008
Kenya	3.986*** (1.001)	8.1 (18.443)		0.19	3.986***	2	0.892	0.787	3.135*	0.769
Malawi	4.174*** (0.786)	-15.82** (6.288)	0.74	10.86***	4.174***	1	2.344	2.124	9.127***	
Mali	4.826*** (1.014)	6.352 (22.18)		0.08	4.826***	1	0.296	0.255	0.687	
Mauritius	4.279*** (0.389)	-0.744 (1.194)	0.201	0.39	4.279***	2	0.508	0.44	2.719*	0.701
Mozambique	7.306*** (0.578)	-2.576 (6.968)	0.101	0.14	7.306***	2	2.961*	2.953*	7.609***	1.573
Namibia	4.851*** (0.625)	-0.096 (0.697)	0.257	2.67*	4.851***	2	0.003	0.002	0.231	0.251
Nigeria	4.656*** (0.645)	-5.116 (29.916)	0.858	50.80***	4.656***	1	0.356	0.289	2.936*	
Senegal	3.979*** (0.319)	-10.145 (7.105)	0.436	2.04	3.979***	3	0.897	0.787	2.258	0.853
Sierra Leone	4.243** (1.821)	49.588 (79.403)	0.057	0.39	4.243**	2	0.016	0.014	2.666*	2.499
South Africa	3.433** (1.532)	-3.062 (8.459)		0.32	3.433***	1	3.518*	3.415*	0.125	

Sudan	5.406***	2.178	0.547	9.61***	5.406***	1	0.536	0.441	6.115**	
	(0.809)	(8.295)								
Swaziland	2.486***	-0.309	0.436	6.21**	2.486***	2	0.003	0.002	1.127	0.533
	(0.272)	(3.711)								
Tanzania	5.541***	1.023		0.36	5.541***	1	1.603	1.482	3.083*	
	(0.533)	(1.711)								
Togo	3.966***	-3.804	0.502	7.91***	3.966***	1	0.979	0.823	7.897**	
	(1.172)	(14.327)								
Uganda	7.093***	-3.1		0.19	7.093***	1	0.559	0.46	2.361	
	(0.588)	(5.115)								
Zambia	4.574***	0.128	0.007	0.01	4.574***	3	0.01	0.009	1.861	1.795
	(0.788)	(1.072)								
Zimbabwe	2.826	13.139	0.276	7.71***	2.826	3	7.244***	9.430***	1.899	0.585
	(2.364)	(8.207)								

Note: Durbin score and Wu-Hausman test for the endogeneity of %ΔU. Sargan score LM test for the validity of instruments used. F test from the first stage regression tests the strength of the instruments.
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Results from TSLS with the lags of %ΔU AND GDPG as instruments based on Equation 4.2

Country	Constant	%ΔU	R^2	F test	Natural rate of growth	lags	Durbin score[N]	Wu-Hausman[N]	F test from first stage regression[N]	Sargan score LM test[N]
Angola	9.615*** (1.775)	17.491 (13.378)		1.71	9.615***	2	10.833***	21.223***	5.374***	3.891
Botswana	5.208*** (0.691)	-0.591 (0.995)	0.536	9.71***	5.208***	2	0.216	0.172	0.683	9.020**
Burkina Faso	5.896*** (0.597)	-0.053 (2.45)	0.005	0	5.896***	1	1.044	0.936	4.158**	0.006
Burundi	0.646 (1.033)	-54.801 (33.419)	0.067	2.69	0.646	2	0.922	0.816	0.909	7.839**
Cameroon	3.814*** (0.286)	0.105 (0.472)	0.097	0.86	3.814***	1	0.033	0.026	1.333	6.029
Central African Rep.	3.967*** (0.857)	-7.933 (13.036)	0.195	0.37	3.967***	3	3.204*	3.246*	2.646*	1.268
Chad	7.466*** (2.523)	23.036 (27.116)		0.72	7.466***	1	9.486***	15.952***	2.372	0.025
Congo, Dem. Rep.	5.589*** (0.697)	6.444 (9.203)	0.795	32.5	5.589***	1	10.459***	18.368***	8.973***	3.799
Congo, Rep.	3.229*** (0.94)	2.91 (16.592)		0.03	3.229***	1	12.455***	28.066***	4.57**	0.387
Equatorial Guinea	16.058*** (4.567)	5.579 (15.982)	0.309	4.03**	16.058***	1	7.642***	10.093***	7.276***	2.6117
Ethiopia	7.829*** (1.409)	6.712 (7.294)		0.85	7.829***	2	1.363	1.236	1.085	3.365

Gabon	2.748*** (0.826)	1.151 (2.756)	0.454	7.32***	2.748***	2	1.827	1.596	2.866*	4.315
Gambia	3.292*** (0.7)	-7.031 (11.431)	0.204	0.38	3.292***	1	3.139*	3.165*	5.521**	2.019
Ghana	5.433*** (0.447)	0.409 (0.352)	0.589	19.94***	5.433***	1	2.094	1.858	1.738	3.218
Kenya	4.219*** (0.953)	13.013 (16.987)		0.59	4.219***	1	2.444	2.363	2.852*	1.025
Malawi	4.178*** (0.806)	-14.9** (6.284)	0.727	10.16***	4.178***	1	3.243*	3.096*	4.634**	0.42
Mali	4.672*** (0.85)	0.201 (16.88)		0	4.672***	1	0.049	0.042	0.428	0.484
Mauritius	4.263*** (0.381)	-0.981 (1.155)	0.235	0.72	4.263***	1	0.219	0.187	1.752	2.773
Mozambique	7.292*** (0.568)	-3.25 (6.272)	0.123	0.27	7.292***	1	3.670**	3.830*	7.112***	1.675
Namibia	4.807*** (0.609)	0.047 (0.327)	0.221	2.55*	4.807***	2	0.169	0.134	0.54	2.573
Nigeria	4.656*** (0.641)	-5.986 (21.37)	0.859	51.38***	4.656***	1	0.727	0.603	3.196*	0.002
Senegal	3.988*** (0.328)	-8.536 (5.377)	0.396	2.52	3.988***	2	5.075**	5.890**	3.746**	1.236
Sierra Leone	4.243** (1.824)	53.686 (78.016)	0.054	0.47	4.243**	1	0.038	0.033	1.755	2.57
South Africa	3.431** (1.436)	-2.873 (4.983)		0.46	3.431**	1	7.892***	10.428***	0.15	0.001

Sudan	5.427*** (0.798)	3.168 (8.154)	0.558	9.91***	5.427***	1	0.335	0.273	2.907*	2.286
Swaziland	2.404*** (0.315)	3.375 (2.679)	0.196	5.14**	2.404***	1	4.533**	4.701**	2.601*	1.666
Tanzania	5.541*** (0.502)	-1.811 (1.361)		1.77	5.541***	1	1.582	1.46	2.198	11.889***
Togo	3.89*** (1.098)	-6.215 (9.245)	0.522	8.42***	3.89***	1	3.366*	3.237*	21.812***	0.061
Uganda	7.086*** (0.573)	-2.593 (4.755)		0.15	7.086***	1	0.43	0.352	1.235	0.137
Zambia	4.881*** (0.825)	1.063 (1.04)		1.04	4.881***	1	1.29	1.158	1.705	5.969
Zimbabwe	3.043 (2.132)	10.751	0.399	9.05***	3.043	1	6.659***	8.220**	1.87	1.295

Note: Durbin score and Wu-Hausman test for the endogeneity of %ΔU. Sargan score LM test for the validity of instruments used. F test from the first stage regression tests the strength of the instruments.
Standard errors are in parenthesis
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Appendix F

The starting point for the extended model of the balance of payments constrained growth rate is the balance of payments accounting identity in disequilibrium (Thirlwall and Hussain, 1982)

$$P_d X + C = P_f M E \qquad \text{(Equation A)}$$

where, C, is the nominal value of net capital inflows measured in the domestic currency[92]. If C<0, there are net capital outflows and if C>0, there are net capital inflows. The rest of the variables are defined as before. The first two terms in Equation A represent the items that provide foreign currency inflows while the right hand side of the equation represents the imports that have to be paid for in foreign currency. Taking the first difference of the variables in logarithmic form yields,

$$\theta(p_d + x) + (1 - \theta)(c) = p_f + m + e \qquad \text{(Equation B)}$$

where, θ, and (1-θ), represent the share of exports and capital flows as a proportion of total receipts respectively. Therefore, $\theta = P_d X/R$ and $(1 - \theta) = C/R$, where R is total receipts which can also be expressed as the import bill financed by export earnings and capital flows. x, is the growth rate of exports, c, is the growth rate of capital flows, m, is the growth rate of imports, p_d, is the growth rate of domestic prices and p_f, is the growth rate of import prices. The import and export demand functions given in Equations 2.40 and 2.41 are substituted into Equation B then solved for the growth of balance of payments constrained income,

$$*** \; y_B = [(1 + \theta\eta + \psi)(p_d - p_f - e) + \theta\varepsilon z + (1 - \theta)(c - p_d))]/\pi \qquad \text{(Equation C)}$$

It can be seen from Equation C that any country's growth rate in principle can be disaggregated into four component parts (Thirlwall, 2011):

1. The growth associated with real terms of trade movements: $(p_d – p_f – e)/\pi$
2. Growth associated with terms of trade movements combined with price elasticities of exports and imports: $((1 + \theta\eta + \psi)$ (pd – pf –e))/π
3. Growth related to exogenous changes in income growth abroad: $\theta\varepsilon z/\pi$
4. Growth effects of real capital flows[93]: (1-θ)$(c - p_d)$]/π

Note that if relative prices measured in a common currency remain unchanged, that is $p_d = p_f + e$, the current account is balanced and there are no capital flows, then the balance of payments constrained income growth in Equation C will be reduced to its basic form expressed in Equation 2.45 in chapter 2.

[92] For simplicity the nominal exchange rate is assumed to be fixed and equal to one (Moreno-Brid, 2003).
[93] Growth in Real capital inflows are defined as $(c\text{-}p_d)$.

Appendix G

The results from the unit root tests are shown below. Included are the Clemente, Montanes and Reyes (CMR) unit root test where,

- Sudden changes in the series are captured by the Additive Outliers (AO)
- Gradual shift in the mean of the series is detected by the Innovational Outliers (IO)

Results from the unit root tests

Country	Variable	CMR2 (AO)	Breaks	CMR1 (AO)	Break	CMR2 (IO)	Breaks	CMR1 (IO)	Break	ADF^N	ADF NC	ADF trend	PP	PP NC	PP trend
Kenya	In_X	-3.742	1987*** 2004***			-4.032	1984*** 2001***			-0.543	3.542	-2.222	-0.767	3.882	-2.755
	ΔIn_X	-7.503***	1988 1995	-1.107	1988	-9.532***	1971 1989	-9.105***	1989	-6.169***			-8.607***		
	In_M	-3.555	1994*** 2007***			-3.449	1991*** 2001***			0.674	2.532	-1.076	0.763	2.179	-1.141
	ΔIn_M	-3.901	1978** 1981**			-5.064	1980 1982*	-4.532**	1982**	-4.745***			-7.012***		
	In_Y	2.265	1974*** 1991***			-4.802	1969** 2002***			-2.360	5.344	-2.409	-1.362	7.060	-1.491
	ΔIn_Y	-4.532	1968 1973**	-8.264***	1980**	-10.853***	1969*** 1973***			-5.077***			-7.222***		
	In_ZY	-3.412	1980*** 2000***			-4.406	1982** 1995***			-3.367**			-4.716***		
	In_REER	-2.234	1987*** 1998***			-3.526	1986*** 1992***			-1.314	0.134	-0.739	-1.478	0.144	-0.921
	ΔIn_REER	-3.361	1986* 1991***			-6.926***	1986*** 1992***			-4.991***			-7.660***		
	In_RPM3			-1.373	1995***	-0.348	1982** 1989***			0.658 (2lag)	-1.112	-0.897	1.028	-1.278	-0.639
	ΔIn_RPM3			-1.960	1982***			-2.566	1979***	-2.475	-2.117	-3.139*	-3.655***	-3.329***	-4.265***
	In_RPM4	-4.128	1975*** 1984***			-4.515	1969** 1976**			-1.157	-1.835	-2.230	-1.044	-1.698	-2.701
	ΔIn_RPM4			-5.591***	1975			-8.910***	1976	-4.626***			-7.389***		
Nigeria	In_X	-5.335	1986** 2003***			-4.980	1995*** 2004***			-0.934	1.015	-2.646	-1.193	0.822	-3.312*
	ΔIn_X			-0.863	2010			-4.131*	2001	-4.547***			-6.907***		
	In_M	-3.790	1997* 2004***					-3.764	1999***	-1.040	0.232	-3.507**	-4.934***		
	In_Y	-3.101	1997*** 2005***			-3.891	1986*** 2002***			1.081	2.198	-1.914	1.152	2.642	-1.775
	ΔIn_Y			-5.563***	2002***			-6.362***	2003	-3.431***			-4.158***		

	In_ZY	-2.597	1991*** 2001***					-2.240	2009	-1.551	4.353	-2.759	-0.956	11.493	-1.192
	ΔIn_ZY			-2.898	2007**			-5.469**	2006**	-4.299***			-4.734***		
	In_REER			-5.563***	1988***			-4.201*	1984***	-2.891**			-2.144*	-0.700	-2.043
	ΔIn_REER			-4.368***	1985			-5.225***	1986	-3.329**			-4.133***		
Sudan	In_X	-4.024	1986** 2000***			-4.809	1983** 1996***			-0.497	1.102	-1.261	-0.371	1.265	-1.144
	ΔIn_X			-6.873***	1997**	-8.009***	1996*** 1998**			-8.470***			-5.475***		
	In_M	-3.485	1976*** 2001***					-3.560	1994***	-1.180	0.755	-2.002	-1.462	0.855	-2.231
	ΔIn_M			-3.778**	2010*	-8.419***	1994** 2003**			-4.890***			-7.697***		
	In_Y[94]	-2.829	1978*** 1999***			-2.045	1972** 1994***			0.743	3.138	-2.530	0.797	4.599	-2.131
	ΔIn_Y			-2.873	1988			-3.397	1989	-5.229***			-5.099***		
	In_ZY	-3.412	1980*** 2000***			-4.404	1982** 2005***			-3.367**			-4.719***		
	In_REER			0.921	1989***	1.986	1990*** 2004***			-2.200	0.158	-2.098	-2.908**	0.283	-2.884
	ΔIn_REER			0.572	1990	-16.03***	1990*** 1994***			-5.831***			-9.464***		
South Africa	In_X	-2.680	1989*** 1997***			-4.160	1983* 1991***			-0.337	2.867	-1.779	-0.503	3.819	-1.713
	ΔIn_X			-6.293***	1993	-6.567***	1990* 2007**			-5.198***			-6.034***		
	In_M	-1.136	1992*** 2004***			-3.243	1992*** 2002**			-0.879	2.295	-2.243	-0.379	2.786	-1.879
	ΔIn_M	-5.137*	1975** 1985**			-7.207***	1970** 1984*			-6.040***			-6.488***		
	In_Y[95]	-3.162	1975*** 2001***			-6.091***	1992*** 2002**			-1.999	2.719	-3.240*	-2.625*	6.278	-2.925
	ΔIn_Y	-4.932*	1983*** 1994**					-5.288***	1970***	-3.035**			-4.076***		
	In_ZY	-3.409	1980*** 2000***			-4.394	1982** 1995***			-3.564***			-4.716***		
	In_REER	-5.491**	1981*** 1997***			-4.270	1982*** 1996***			-1.442	-1.036	- 4.388***	-1.157	-1.242	-3.518**
	ΔIn_REER			-4.673***	2000			-6.030***	2001*	-6.379***			-6.285		

94 For Sudan In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
95 For South Africa In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

Benin	In_X	-3.017	1970*** 1993***					-3.397	1988***	-1.617	2.023	-3.576**	-0.960	2.466	-2.432
	ΔIn_X			-7.207***	1996			-7.315***	1970**	-6.345***			-5.319***		
	In_M	-4.063	1972*** 1994***					-3.996	1988***	-2.143	2.158	-3.368*	-1.353	2.429	-2.212
	ΔIn_M	-3.576	1979** 1987*			-5.691***	1980*** 1988***			-4.244***			-5.760***		
	In_Y[96]	-1.649	1982*** 1998***			-1.143	1977*** 1994**			1.316	5.456	-1.967	1.708	10.022	-1.747
	ΔIn_Y			-3.391*	1098			-3.747	1988***	-6.199***			-7.054***		
	In_ZY	-3.412	1980*** 2000***		-4.403	1982** 1995***				-3.367**			-4.715***		
	In_REER	-2.768	1976*** 1984***		- 6.015***	1973*** 1979***				-2.436	-1.505	-1.408	-2.465	-1.700	-1.195
	ΔIn_REER			-4.673***	1992			-6.914***	1982**	-4.530***			-6.090***		
Botswana	In_X	-3.886	1984*** 1996***					-3.043	1980	-2.068	2.457	-2.423	-2.688*	3.082	-2.709
	ΔIn_X			-3.102	2007			-6.067***	1987***	-4.695***			-6.052***		
	In_M	-3.003	1990*** 2009***			-3.233	1985** 2005**			-0.960	2.351	-3.585**	-0.992	3.724	-2.838
	ΔIn_M			-3.673**	1995	-6.038***	1989** 1996*			-4.952***			-4.750***		
	In_Y	-3.063	1985*** 1999***					-2.149	2012	-3.408**	3.059	-2.175	-4.562***		
	ΔIn_Y	-7.141***	1986*** 1990***					-3.966	1990***	-3.988***			-4.002***		
	In_ZY	-2.901	1989*** 2001***					-1.904	1981	-0.951	4.184	-2.175	-1.611	12.175	-2.692
	ΔIn_ZY			-3.814**	2007**			-5.260***	2006*	-4.363***			-4.701***		
	In_REER	-3.786	1986*** 1999***					-2.029	1983	-1.731	0.147	-1.703	-1.818	0.083	-1.742
	ΔIn_REER	-3.269	1982* 1988***	-4.811***	1983	-7.092***	1983*** 1987***			-4.109***			-5.364***		
Cameroon	In_X	-1.019	1975*** 1981***			-4.472	1967** 1976***			-0.735	2.265	-1.685	-0.567	2.490	-1.784
	ΔIn_X	-3.888	1975*** 1985***			-7.047***	1976*** 1984***			-5.408***			-6.973***		
	In_M[97]	-3.461	1978*** 2001***			-2.190	1974** 1991*			0.233	3.153	-2.488	0.353	3.458	-2.808

[96] For Benin In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[97] For Cameroon In_M, 4 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

	ΔIn_M	-8.078***	1987** 1990**			-8.175***	1985*** 1991***			-6.203***			-7.989***		
	In_Y	-3.229	1979*** 2002***			-3.211	1975** 1999**			-0.898	1.355	-3.051	-0.658	3.431	-1.556
	ΔIn_Y	-2.394	1986*** 1991***			-7.521***	1985*** 1992***			-3.174**			-5.349***		
	In_ZY	-3.415	1980*** 2000***			-4.405	1982** 1995***			-3.365**			-4.713***		
	ΔIn_ZY	-4.469	1971*** 2007**			-7.376***	1972*** 2006***								
	In_REER	-1.525	1985** 1991***			-7.547***	1973** 1992***			-1.568	-0.350	-2.221	-1.945	-0.471	-2.555
	ΔIn_REER			-12.344***	1992					-5.668***			-8.171***		
Chad	In_X	-0.576	1980*** 2002***			-6.354***	1981*** 2002***			-1.046	1.064	-2.853	-0.972	1.244	-2.539
	ΔIn_X			-5.230**	2002**			-7.036***	1981	-6.038***			-7.026***		
	In_M[98]	-1.192	1986*** 1998***			-5.683**	1981*** 2000***			-2.403	0.626	- 4.144***	-2.609*	0.385	-3.240*
	ΔIn_M			-3.671**	2000			-4.299**	1999	-4.400***			-5.955***		
	In_Y	-0.472	1993*** 2006***			-3.655	1983*** 2001***			1.352	2.340	-1.017	1.601	2.603	-0.902
	ΔIn_Y			-5.556***	2002**			-7.188***	1978*	-4.311***			-5.945***		
	In_ZY	-3.413	1980*** 2000***			-4.405	1982** 1995***			-3.368**	3.721	-2.958	-4.718***	10.620	-2.691
	ΔIn_ZY	-4.470	1971*** 2007**			-7.374***	1972*** 2006**								
	In_REER	-3.125	1980*** 1991***			-5.845**	1980*** 1992***			-1.275	-1.015	-1.713	-1.219	-1.172	-1.642
	ΔIn_REER	-8.085***	1992* 1996**					-9.213***	1993*	-5.160***			-6.182***		
Congo, Dem. Rep.	In_X	-4.374	1979*** 2004***			-3.167	1981* 2000***			-0.256	1.591	-1.768	-0.294	1.898	-1.771
	ΔIn_X	-8.014***	1989** 1994***			-7.998***	1990*** 1993***			-5.626***			-6.699***		
	In_M	-6.038***	1976*** 2004***					-2.155	1996**	-1.096	1.224	-2.142	-1.174	1.513	-2.098
	ΔIn_M					-5.260*	1990*** 1993***			-5.506***			-6.147***		
	In_Y[99]	-3.793	1994*** 2007***			-3.471	1988*** 2005***			-2.122	0.470	-1.756	-1.078	0.764	-0.906
	ΔIn_Y	-5.070	1989*** 1999***			-5.671**	1988*** 2000***			-1.955	-1.900	-1.998	-3.007**		

[98] For Chad In_M, 3 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[99] For the Democratic Republic of Congo In_Y, 3 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

	In_ZY	-2.953	1980*** 1999***			-4.180	1982** 1995***			-2.671*	3.959	-2.932	-4.221***		
	ΔIn_ZY	-7.444***	1971*** 2007**			-7.228***	1972*** 2006**								
	In_REER			-3.458*	1985***	-5.292*	1982*** 1999**			-1.563	-0.759	-2.495	-2.023	-1.105	-2.693
	ΔIn_REER			-3.141	1997	-7.918***	1999** 2004**			-5.053***			-7.002***		
Congo, Rep.	In_X	-3.563	1981*** 1994***			-3.837	1978** 2007**			-1.298	2.064	-1.657	-2.281	3.640	-2.165
	ΔIn_X			-6.353***	1981*			-6.310***	1982	-4.585***			-5.965***		
	In_M	-4.273	1990*** 2004***			-4.441	1991*** 2004***			-0.174	1.639	-2.554	-0.212	1.827	-2.604
	ΔIn_M			-1.102	1980			-5.873***	1992	-5.348***			-7.076***		
	In_Y[100]	-4.228	1983*** 2007***			-4.643	1976*** 2003***			-1.125	2.046	-2.485	-1.433	3.559	-2.092
	ΔIn_Y	-5.174*	1979*** 1982***					-4.514**	1981***	-3.552***			-3.781***		
	In_ZY	-2.977	1985*** 2000***			-3.023	1982* 1995**			-1.610	4.401	-3.243*	-2.269	12.538	-2.697
	ΔIn_ZY			-5.894***	1980**			-5.898***	1972*	-4.962***			-4.915***		
	In_REER	-1.721	1982*** 1990***			-4.785	1979*** 1986**			-1.444	-0.787	-1.364	-1.531	-1.112	-1.093
	ΔIn_REER			-6.521***	1992			-7.062***	1993*	-4.841***			-5.388***		
Gabon	In_X	-2.111	1971*** 1990***			-8.203***	1972*** 1987***			-3.351**			-3.663***		
	ΔIn_X			-1.856	1977***										
	In_M	-3.771	1971*** 1975***					-6.102***	1972***	-2.758*			-2.962**		
	ΔIn_M			-2.053	1972										
	In_Y	-1.139	1971*** 1991***			-3.872	1971*** 1986***			-1.900	1.867	-2.169	-2.323	2.495	-2.161
	ΔIn_Y	-2.691	1971* 1974***					-2.436	1973	-4.325***			-5.287***		
	In_ZY	-3.412	1980*** 2000***			-4.401	1982** 1995***			-3.363**			-4.711***		
	ΔIn_ZY	-4.474	1971*** 2007***			-7.372***	1972*** 2006**								
	In_REER	-5.376	1975*** 1991***			-7.030***	1973*** 1992***			-0.718	-1.025	-1.793	-0.793	-0.939	-2.033
	ΔIn_REER			-7.870***	1992			-10.043***	1993	-5.290***			-7.629***		

[100] For the Republic of Congo In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

Gambia	In_X[101]			-3.808**	1978***			-4.525***	1979***	-2.332	0.545	-3.250*	-2.055	0.938	-2.532
	ΔIn_X									-4.154***			-5.046***		
	In_M			-2.810	1974***			-4.388**	1975***	-2.425	0.762	-2.810	-2.390	0.748	-2.819
	ΔIn_M									-3.840***			-6.353***		
	In_Y	-2.735	1979*** 2000***			-3.466	1971*** 1996**			-1.480	5.790	-2.554	-1.148	8.763	-2.296
	ΔIn_Y			-6.530***	1973	-6.901***	1973*** 1977***			-5.467***			-7.829***		
	In_ZY	-2.937	1984*** 2000***			-3.537	1982** 1995**			-2.263	4.033	-3.496**	-3.128**	11.364	-3.031
	ΔIn_ZY			-6.283***	1971***	-7.069***	1972*** 2006**								
	In_REER	-6.123***	1983*** 2000***			-6.480***	1984*** 2000***			-0.284	-1.647	-2.028	-0.289	-1.810	-2.005
	ΔIn_REER									-4.350***			-6.159***		
Mali	In_X	-3.096	1981*** 1998***			-3.039	1975*** 1995***			0.149	4.469	-2.440	0.552	5.804	-3.262*
	ΔIn_X			-2.823	1995			-9.233***	2001	-5.994***			-8.900***		
	In_M	-3.051	1981*** 1998***			-4.213	1976** 1995***			-0.621	2.905	-2.780	-0.338	3.524	-3.255*
	ΔIn_M			-5.922***	1983			-8.087***	1984	-5.130***			-7.971***		
	In_Y	-2.688	1980*** 1998***					-1.333	1994**	1.025	3.584	-0.669	0.950	4.206	-0.912
	ΔIn_Y	-1.929	1977** 1985**	-7.197***	1995*			-6.958***	1995**	-4.370***			-6.446***		
	In_ZY[102]	-3.721	1980*** 1996***			-3.741	1982** 1994***			-1.086	4.224	-3.334*	-1.881	12.276	-3.998***
	ΔIn_ZY			-3.183	1971**			-6.121***	1972**						
	In_REER	-5.260	1978* 1991***			-5.804***	1985* 1992***			-0.726	-0.470	-3.077	-0.988	-0.331	-2.940
	ΔIn_REER			-6.981***	1992			-1.128	1993	-4.676***			-7.090***		
Mauritius	In_X	-3.497	1989*** 2002***			-4.748	1984*** 2003***			-0.822	2.970	-1.450	-1.143	4.248	-1.476
	ΔIn_X	-6.688***	1983*** 1988***			-7.214***	1984*** 1988***			-3.518***			-5.121***		
	In_M[103]	-5.267	1989*** 2000***			-5.066	1984*** 1995***			-0.992	1.382	-2.340	-0.856	2.103	-1.742

[101] For Gambia In_X, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[102] For Mali In_ZY, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[103] For Mauritius In_M, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

	ΔIn_M	-5.483*	1984*** 1989***			-6.474***	1984*** 1990***			-2.874**			-3.443***		
	In_Y	-2.813	1989*** 2001***					-4.824***	1983***	-0.058	4.435	-2.114	-0.220	7.862	-1.938
	ΔIn_Y			-2.917	1982*					-3.896***			-5.621***		
	In_ZY	-2.862	1989*** 2001***					-1.819	1981	-0.857	4.155	-2.958	-1.252	12.655	-2.372
	ΔIn_ZY			-3.987***	2007**			-5.155***	2006*	-4.550***			-4.576***		
	In_REER			-2.037	1981**	-3.221	1985** 2008**			-1.966	0.094	-1.822	-2.115	0.118	-2.053
	ΔIn_REER			-2.546	2003			-6.295***	2006*	-3.764***			-5.851***		
Mozambique	In_X[104]	-4.951	1997** 2004**			-4.326	1992*** 1998***			-0.400	1.255	- 4.664***	0.572	1.879	-3.693**
	ΔIn_X	-4.366	1997*** 2004*					-5.580***	1985***						
	In_M	-3.413	1996*** 2006***			-2.513	1997** 2007**			-0.741	1.658	-2.643	0.874	1.564	-2.874
	ΔIn_M			-6.545***	1983*			-3.325	1984	-4.072***			-5.776***		
	In_Y[105]	-2.666	1995*** 2005***					-0.068	1994**	0.701	2.219	- 5.374***	1.499	3.129	-3.466**
	ΔIn_Y			-1.247	1984***			-1.993	1985	-2.820*		-3.299**			
	In_ZY	-2.639	1990*** 2001***					-1.839	1982**	-0.865	4.078	-2.561	-0.752	11.811	-2.015
	ΔIn_ZY			-3.449*	2007**			-6.219***	2008	-4.674***			-4.414***		
	In_REER			-5.567***	1988***	-9.893***	1983*** 1985***			-1.836	-0.392	-2.455	-1.707	0.455	-2.167
	ΔIn_REER									-4.225***			-4.899***		
Namibia	In_X	-4.400	1992*** 2003***			-4.511	1989*** 2000***			-0.550	1.794	-3.812**	-0.165	1.897	-3.838**
	ΔIn_X			-2.837	1988			-5.195***	1989						
	In_M[106]	-4.641	1997*** 2008***			-4.300	1994*** 2005***			2.432	2.438	-0.807	2.011	2.881	-1.034
	ΔIn_M			0.203	2002	-7.391***	2005*** 2008***			-1.966	-0.774	-2.947	-3.926***		
	In_Y	-3.388	1993*** 2005***					0.179	2001	1.841	3.461	-2.671	2.661	5.813	-2.525
	ΔIn_Y	-6.139***	1983** 2002**					-5.502***	1984**	-3.438**			-4.237***		
	In_ZY	-2.639	1990*** 2001***					-1.839	1982**	-0.865	4.078	-2.562	-0.751	11.811	-2.016

[104] For Mozambique In_X, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[105] For Mozambique In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[106] For Namibia In_M, 4 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

	ΔIn_ZY			-3.449*	2007**			-6.217***	2008	-4.674***			-4.414***		
	In_REER[107]			-4.713***	1986***			-4.942***	1982*	-2.702*	-0.737	-2.269	-2.280	-0.735	-2.036
	ΔIn_REER									-3.606***			-4.593***		
Senegal	In_X[108]	-4.751	1978*** 1995***					-2.528	1992***	0.139	3.217	-2.302	-1.057	2.209	-5.192***
	ΔIn_X			-6.903***	1978	-7.130***	1976*** 1980***			-6.614***			-11.304***		
	In_M[109]	-3.608	1978*** 2000***			-2.236	1973*** 1996***			0.618	2.600	-2.539	-0.395	3.214	-3.360*
	ΔIn_M			-2.964	1975	-2.650	1976** 1980*			-4.981***			-10.612***		
	In_Y	-2.768	1983*** 2000***			-2.301	1973** 1996***			2.117	4.850	-0.795	2.303	7.899	-1.135
	ΔIn_Y			-11.586***	1995*			-11.398***	1993***	-4.878***			-10.413***		
	In_ZY	-3.413	1980*** 2000***			-4.404	1982** 1995***			-3.367**	3.712	-2.959	-4.716***	10.621	-2.691
	ΔIn_ZY	-4.470	1971*** 2007**			-7.374***	1972*** 2006**								
	In_REER			-5.242***	1991***			-5.810***	1992***	-0.978	-0.934	-2.062	-1.136	-0.970	-2.299
	ΔIn_REER									-5.027***			-7.543***		
Sierra Leone	In_X	-0.556	1979*** 2004***					-2.645	2011***	0.152	0.735	0.870	0.142	0.860	1.040
	ΔIn_X			-7.797***	2009***	-8.385***	1994** 2011***			-3.020**			-5.595***		
	In_M	-2.858	1977*** 2004***			-2.931	1998*** 2009**			0.050	0.818	-0.412	-0.138	0.853	-0.444
	ΔIn_M			-4.504***	1999***			-4.713***	1999***	-3.688***			-6.789***		
	In_Y	-1.709	1999*** 2008***			-0.088	1990*** 2000***			1.091	2.182	0.217	0.955	2.227	-0.024
	ΔIn_Y	-4.044	1989** 1999***			-6.420***	1990*** 2000***			-3.010**			-5.776***		
	In_ZY[110]	-2.986	1985*** 2000***			-3.259	1982* 1995**			-1.953	3.290	-2.842	-3.037**	11.542	-3.376*
	ΔIn_ZY	-6.859***	1980** 2007*					-6.275***	1972**	-5.010***			-4.858***		
	In_REER	-2.316	1982** 1987***			-4.810	1981*** 1984***			-2.938**	-0.309	-3.350*	-2.531*	-0.326	-2.810
	ΔIn_REER			-2.189	1984	-8.588***	1979*** 1985***			-6.125***			-5.874***		

[107] For Namibia In_REER, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[108] For Senegal In_X, 4 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[109] For Senegal In_M and In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[110] For Sierra Leone In_ZY, 3 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

Togo	In_X	0.460	1968*** 1978***					-1.693	1969	-0.909	2.326	-1.623	-1.350	2.419	-2.183
	ΔIn_X			-0.743	1969			-9.993***	1970	-5.316***			-8.691***		
	In_M[111]	-3.491	1972*** 1978***					-2.613	1973**	-1.414	1.399	-2.578	-1.058	1.581	-2.078
	ΔIn_M			-0.502	2009**			-5.838***	1976	-3.697***			-5.365***		
	In_Y	-3.177	1974*** 1998***			-5.713**	1992*** 2008***			-1.981	3.317	-3.047	-2.450	4.038	-3.300*
	ΔIn_Y			-3.092	1991					-4.390***			-6.584***		
	In_ZY	-3.413	1980*** 2000***			-4.403	1982** 1995***			-3.367**	3.722	-2.959	-4.715***	10.624	-2.691
	ΔIn_ZY	-4.470	1971*** 2007**			-7.373***	1972*** 2006**			-3.877***					
	In_REER	-2.658	1981*** 1991***			-8.130***	1982*** 1992***			-1.408	-0.788	-1.811	-1.577	-0.916	-2.131
	ΔIn_REER			-8.741***	1992			-12.021***	1993	-5.972***			-8.246***		
Uganda	In_X	-4.295	1998*** 2009***			-2.933	1993*** 2003**			0.258	3.023	-2.545	0.468	3.372	-2.832
	ΔIn_X			-2.960	2006			-7.552***	2007	-3.920***			-6.186***		
	In_M[112]	-3.281	1996*** 2007***					0.144	1993***	-0.052	2.621	-2.506	0.178	3.357	-2.434
	ΔIn_M			-5.271***	1993**			-3.244	1994**	-3.234**			-3.604***		
	In_Y[113]	-2.596	1996*** 2005***					-0.798	1991**	0.378	2.934	- 4.670***	1.251	7.918	-3.404**
	ΔIn_Y			-4.973***	1987***			-2.713	1986	-3.823***			-3.105**		
	In_ZY	-2.772	1994*** 2004***					-2.111	1994	-1.593	3.995	-2.789	-1.752	11.845	-1.990
	ΔIn_ZY			-2.802	2007**			-5.160***	2006**	-4.018***			-4.373***		
	In_REER[114]	-4.972	1990*** 1999*					1.270	1989	-2.809*	-2.119	-1.124	-3.882***	-2.161	-3.103
	ΔIn_REER			-6.261***	1990**			-6.829***	1991***	-3.549***					
Zambia	In_X	-5.869***	2000*** 2006***			-3.933	1997*** 2001***			2.101	2.277	0.427	2.365	2.366	0.392
	ΔIn_X					-9.247***	1997*** 2004***			-3.103**			-5.456***		
	In_M[115]	-2.603	1979** 2002***			-3.258	1973** 1997***			0.720	1.417	-0.224	1.419	1.900	0.075

[111] For Togo In_M, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[112] For Uganda In_M, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[113] For Uganda In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[114] For Uganda In_REER, 4 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[115] For Zambia In_M and In_RPM2, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

	ΔIn_M	-6.903***	1970* 1991***					-4.982***	1992***	-2.089			-4.513***		
	In_Y	-1.239	1996*** 2006***			-2.365	1994** 2003***			2.056	3.764	0.770	1.984	4.132	0.520
	ΔIn_Y			-8.567***	2000***			-8.283***	2001***	-3.600***			-6.639***		
	In_ZY	-3.358	1980*** 2000***			-4.399	1982** 1995***			-3.336**	3.693	-2.919	-4.645***	10.561	-2.639
	ΔIn_ZY	-7.069***	1971** 1980*			-7.313***	1972*** 2006**								
	In_REER[116]	-6.444***	1984*** 2003***			-6.480***	1985** 2003***			-0.699	0.600	-1.311	-1.385	0.441	-1.890
	ΔIn_REER									-4.030***			-5.282***		
	In_RPM2	-4.453	1988*** 1993***					-6.164***	1989***	-2.537*	- 2.827**	-0.674	-2.184	-3.263***	-0.009
	ΔIn_RPM2	-6.363***	1990*** 1994***			-6.243***	1989*** 1993***								
	In_RPM4	-4.626	1997*** 2007*			1.537	1996** 2004***			-1.615	-1.107	-2.349	-2.043	-1.265	-2.947
	ΔIn_RPM4			-5.950***	2004			-7.866***	2005	-5.023***			-7.912***		
Zimbabwe	In_X	-2.741	1987*** 2004***			-4.145	1978** 2000***			-1.752	0.499	-1.680	-1.675	0.405	-1.546
	ΔIn_X	-4.640	1999*** 2008***			-2.347	1998** 2007***			-3.492***			-5.496***		
	In_M	-2.930	1987*** 2010***					-1.762	1984	-1.287	1.237	-1.745	-1.418	1.210	-2.107
	ΔIn_M	-4.732	1997** 2007***					-2.643	2008*	-4.539***			-7.310***		
	In_Y[117]	-3.578	1990*** 2004***					-1.066	2000**	-2.527	0.799	-2.291	-1.713	0.728	-1.566
	ΔIn_Y	-1.292	1999** 2006**			-7.800***	2000*** 2007***			-2.584*			-3.833***		
	In_ZY	-2.868	1989*** 2001***					-1.818	1981	-0.856	4.155	-2.959	-1.251	12.653	-2.373
	ΔIn_ZY			-3.986***	2007**			-5.156***	2006*	-4.549***			-4.577***		
	In_RPM2			-3.597**	1990***			-4.021	1987***	-1.233	-1.543	-1.134	-1.535	-1.714	-1.507
	ΔIn_RPM2							-5.492**	1987** 1995***	-3.697***			-6.540***		
	In_RPM4			-4.058***	1990***	-6.039***	1983*** 1987***			-2.289	-1.860	-2.513	-3.182**	-2.679	-3.282*
	ΔIn_RPM4									-4.709***					

Note: The ADF unit root test uses one lagged value as determined by the presence of autocorrelation unless otherwise stated.
5% critical value for the CMR2 is -5.490
5% critical value for CMR1 is -3.560

[116] For Zambia In_REER, 3 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.
[117] For Zimbabwe In_Y, 2 lags were used in the Augmented Dickey fully (ADF) unit root test due to autocorrelation.

5% critical value for ADF is -2.928
5% critical value for ADF no constant -1.950
5% critical value for ADF trend -3.497
5% critical value for PP is -2.927
5% critical value for PP trend -3.496
5% critical value for PP no constant -1.950
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Appendix H
Results from the import demand function

<u>Results from the ARDL model</u>

$$Kenya\ \Delta InM = -2.822(1.641) - 0.347(0.103)InM_{t-1} + 0.342(0.114)InY_t - 0.519(0.211)IniREER_t + 0.260(0.085)D1963to78 + 0.287(0.091)D1990onward$$

$$Sudan\ \Delta InM = 0.035(1.338) - 0.261(0.094)InM_{t-1} + 0.249(0.102)InY_t + 0.046(0.079)IniREER_t$$

$$Nigeria\ \Delta InM = -0.636(3.835) - 0.499(0.163)InM_{t-1} + 0.470(0.288)InY_t - 0.074(0.060)InREER_t + 0.204(0.127)\Delta InM_{t-1} + 3.270(0.778)\Delta InY_t + 1.192(0.419)\Delta InY_{t-1} - 0.947(0.479)\Delta InY_{t-2} + 2.163(0.455)\Delta InY_{t-3} + 0.233(0.111)\Delta InREER_t - 0.473(0.177)D1988 - 0.625(0.192)D1999 - 1.311(0.235)D2004$$

$$South\ Africa\ \Delta InM = -6.526(1.523) - 0.196(0.041)InM_{t-1} + 0.407(0.072)InY_t - 0.135(0.069)IniREER_t + 3.982(0.346)\Delta InY_t - 0.106(0.057)D1982 + 0.167(0.057)D1992$$

$$South\ Africa\ Post\ Apartheid\ \Delta InM = -6.417(1.517) - 0.239(0.054)InM_{t-1} + 0.434(0.075)InY_t - 0.186(0.080)IniREER_t + 3.763(0.403)\Delta InY_t - 0.104(0.057)D1982 + 0.164(0.058)D1992 + 0.050(0.040)D1994onward$$

$$South\ Africa\ trend\ \Delta InM = -15.614(4.418) - 0.208(0.039)InM_{t-1} + 0.170(0.129)InY_t - 0.221(0.077)IniREER_t + 3.872(0.352)\Delta InY_t - 0.091(0.055)D1982 + 0.132(0.058) + 0.007(0.003)t$$

$$South\ Africa\ Post\ Apartheid\ trend\ \Delta InM = -14.170(6.481) - 0.195(0.067)InM_{t-1} + 0.192(0.159)InY_t - 0.209(0.117)IniREER_t + 4.139(0.452)\Delta InY_t - 0.389(0.444)\Delta InY_{t-1} + 0.058(0.106)\Delta IniREER_t - 0.008(0.120)\Delta IniREER_{t-1} + 0.143(0.062)D1992 + 0.004(0.053)D1994onward + 0.006(0.004)t$$

$$Benin\ \Delta InM = -3.329(1.036) - 0.345(0.079)InM_{t-1} + 0.394(0.086)InY_t - 0.373(0.074)IniREER_t + 3.229(0.419)\Delta InY_t + 0.294(0.131)\Delta IniREER_t - 0.129(0.079)D1982 - 0.144(0.074)D1984 + 0.170(0.072)D1992$$

$$Botswana\ \Delta InM = -1.037(0.911) - 0.954(0.196)InM_{t-1} + 0.855(0.168)InY_t - 0.508(0.216)IniREER_t + 0.828(0.173)\Delta InM_{t-1} + 0.094(1.154)\Delta InM_{t-2} + 0.472(0.152)\Delta InM_{t-3} + 0.534(0.318)\Delta InY_t - 0.181(0.067)D1996 - 0.196(0.069)D2005 + 0.291(0.075)D2012$$

$$Cameroon\ \Delta InM = -3.735(1.504) - 0.507(0.123)InM_{t-1} + 0.700(0.170)InY_t + 0.333(0.119)IniREER_t - 0.213(0.100)D1$$

$$Chad\ \Delta InM = 4.976(2.946) - 0.835(0.138)InM_{t-1} + 0.549(0.199)\text{InY}_t - 0.233(0.145)IniREER_t + 0.218(0.129)\Delta InM_{t-1} + 0.715(0.111)\Delta InM_{t-2} + 0.385(0.141)D2001 + 1.080(0.144)D2002$$

$$Republic\ of\ Congo\ InM = 2.852(1.520) + 0.173(0.077)InM_{t-1} - 0.258(0.110)InY_t + 0.180(0.079)IniREER_t - 0.588(0.100)\Delta InM_{t-1} - 0.408(0.124)\Delta InM_{t-2} + 0.556(0.146)\Delta InM_{t-3} - 0.337(0.332)\Delta InY_t + 1.048(0.329)\Delta InY_{t-1} + 1.231(0.329)\Delta InY_{t-2} - 0.964(0.350)InY_{t-3} - 0.420(0.232)\Delta IniREER_t - 0.167(0.219)\Delta IniREER_{t-1} - 0.467(0.227)\Delta IniREER_{t-2} - 0.999(0.231)\Delta IniREER_{t-3} + 0.218(0.102)D1980 + 0.525(0.086)D1981 + 0.870(0.113)D1982 + 0.346(0.090)D1990 + 0.854(0.081)D1991 + 0.556(0.127)D1993 + 0.546(0.160)D1994 + 0.828(0.183)D1995 - 0.239(0.134)D1997 - 0.105(0.066)D2004$$

$$Democratic\ Republic\ of\ Congo\ \Delta InM = -6.153(6.823) - 0.190(0.085)InM_{t-1} + 0.416(0.348)InY_t - 0.053(0.088)IniREER_t + 0.141(0.147)\Delta InM_{t-1} - 0.215(0.124)\Delta InM_{t-2} + 2.367(0.857)\Delta InY_t - 1.285(0.975)\Delta InY_{t-1} - 0.043(0.135)\Delta IniREER_t + 0.352(0.132)\Delta IniREER_{t-1} + 0.388(0.153)D1997onward$$

$$Gabon\ \Delta InM = -3.618(2.052) - 0.313(0.107)InM_{t-1} + 0.399(0.159)InY_t - 0.266(0.119)IniREER_t + 0.580(0.228)\Delta InY_t + 0.402(0.127)D197$$

$$Gambia(AIC)\ \Delta InM = 3.343(2.166) - 0.381(0.113)InM_{t-1} + 0.181(0.087)InY_t - 0.095(0.099)IniREER_t + 0.171(0.140)\Delta InM_{t-1} + 0.312(0.139)\Delta InM_{t-2} + 0.200(0.111)D1977 + 0.200(0.116)D1979 - 0.215(0.109)D1994$$

$$Mali\ \Delta InM = -3.102(2.648) - 0.104(0.081)InM_{t-1} + 0.229(0.165)InY_t - 0.066(0.212)IniREER_t - 0.619(0.431)\Delta InY_t - 0.193(0.206)\Delta IniREER_t - 0.002(0.125)D1960to1992$$

$$Mauritius\ \Delta InM = -1.951(1.426) - 0.179(0.064)InM_{t-1} + 0.212(0.066)InY_t - 0.203(0.229)IniREER_t + 2.280(0.459)\Delta InY_t + 2.527(0.502)\Delta InY_{t-1} + 0.369(0.219)\Delta IniREER_t + 0.592(0.217)\Delta IniREER_{t-1} - 0.109(0.207)\Delta IniREER_{t-2} - 0.603(0.228)\Delta IniREER_{t-3} - 0.155(0.053)D1982 - 0.097(0.049)D1985 + 0.134(0.050)D1990 + 0.150(0.052)D2006$$

$$Mozambique\ \Delta InM = 110.077(48.765) - 0.882(0.174)InM_{t-1} + 1.655(0.464)InY_t - 0.148(0.057)IniREER_t - 1.669(0.590)\Delta InY_t + 0.724(0.324)\Delta InY_{t-1} + 0.203(0.083)\Delta IniREER_t - 0.290(0.095)D1977to1992 - 0.064(0.028)t$$

$$Namibia\ \Delta InM = -6.360(1.887) - 0.281(0.101)InM_{t-1} + 0.548(0.164)InY_t - 0.041(0.175)InREER_t - 0.761(0.494)\Delta InY_t + 0.911(0.534)\Delta InY_{t-1} + 0.171(0.154)\Delta IniREER_t + 0.689(0.161)\Delta IniREER_{t-1} - 0.170(0.073)D2005 + 0.148(0.065)D2007$$

$$Senegal\ \Delta InM = -2.348(1.368) - 0.600(0.137)InM_{t-1} + 0.665(0.146)InY_t - 0.075(0.075)IniREER_t + 0.233(0.066)D1981 + 0.039(0.032)D1982to1989$$

$$Sierra\ Leone\ \Delta InM = -5.053(3.802) - 0.197(0.082)InM_{t-1} + 0.456(0.189)InY_t + 0.134(0.157)IniREER_t + 0.770(0.583)\Delta InY_t + 0.811(0.334)\Delta IniREER_t - 0.672(0.339)D1986 - 0.757(0.246)D1990$$

$$Uganda\ \Delta InM = 3.822(3.030) + 0.284(0.301)InM_{t-1} - 0.442(0.408)InY_t + 0.034(0.057)IniREER_t - 0.670(0.268)\Delta InM_{t-1} - 0.490(0.180)\Delta InM_{t-2} - 0.376(0.175)\Delta InM_{t-3} + 3.559(0.800)\Delta InY_t + 2.660(0.728)\Delta InY_{t-1} + 1.193(0.640)\Delta InY_{t-2} + 1.525(0.595)\Delta InY_{t-3} - 0.151(0.110)\Delta IniREER_t - 0.700(0.115)\Delta IniREER_{t-1} + 0.123(0.082)\Delta IniREER_{t-2} + 0.277(0.063)D1987 - 0.208(0.060)D1994 - 0.068(0.021)D2002to2006$$

$$Zambia\ \Delta InM = -12.547(4.972) - 0.166(0.124)InM_{t-1} + 0.757(0.306)InY_t - 0.044(0.015)InRPM2_t - 0.288(0.198)\Delta InM_{t-1} - 2.639(1.040)\Delta InY_t - 4.526(1.216)\Delta InY_{t-1} - 4.860(1.305)\Delta InY_{t-2} - 3.457(1.196)\Delta InY_{t-3} + 0.768(0.125)\Delta InRPM2_t + 0.151(0.104)\Delta InRPM2_{t-1} + 0.066(0.097)\Delta InRPM2_{t-2} + 0.157(0.095)\Delta InRPM2_{t-3} + 0.509(0.103)\Delta InRPM2_{t-4} - 0.628(0.237)D1985 - 0.297(0.158)D1988$$

$Zimbabwe\ \Delta InM = -114.102(25.102) - 0.826(0.175)InM_{t-1} + 0.964(0.311)InY_t - 0.232(0.121)InRPM2_t - 0.477(0.149)\Delta InRPM2_t - 0.715(0.126)D1999onw$ard

Results from OLS

$$Democratic\ Republic\ of\ Congo\ \Delta InM = 0.039(0.031) + 2.372(0.605)\Delta InY - 0.053(0.127)IniREER$$

$$Gabon, robust, \Delta InM = 0.003(0.020) + 0.979(0.284)\Delta InY - 0.178(0.221)\Delta IniREER + 0.460(0.084)D1974$$

$$Togo, robust, \Delta InM = 0.008(0.025) + 1.608(0.495)\Delta InY - 0.834(0.203)\Delta IniREER$$

$$Uganda, robust, \Delta InM = -0.036(0.029) + 2.061(0.613)\Delta InY - 0.225(0.059)\Delta IniREER$$

$$Sudan\ \Delta InM = -0.007(0.036) + 0.963(0.562)\Delta InY - 0.095(0.094)\Delta IniREER$$

$$Mali\ \Delta InM = 0.033(0.023) + 0.049(0.374)\Delta InY - 0.099(0.169)\Delta IniREER + 0.338(0.113)D1978 + 0.261(0.121)D1985$$

$$Sierra\ Leone\ \Delta InM = 0.018(0.037) + 0.775(0.501)\Delta InY + 0.416(0.216)\Delta IniREER - 0.491(0.244)D1990$$

Appendix I
Results from the export demand function

Results from the ARDL model

Kenya $\Delta \text{InX} = -1.106(1.293) - 0.077(0.083) InX_{t-1} + 0.0948\ (0.090) InZY - 0.033(0.073) InREER - 0.377(0.159)\Delta InREER$

$Nigeria\ \Delta InX = -17.597(7.200) - 0.6238(0.172) InX_{t-1} + 1.041(0.333) InZY_t + 0.021(0.074) InREER_t - 0.388(0.210) D2001$

$Sudan\ \Delta InX = 3.015(1.711) - 0.094(0.039) InX_{t-1} + 0.067(0.056) InZY_t - 0.648(0.110) InREER_t - 0.131(0.137)\Delta InX_{t-1} - 0.429(0.137)\Delta InX_{t-2} + 0.497(0.114)\Delta InREER_t + 0.431(0.956)\Delta InREER_{t-1} + 0.341(0.093)\Delta InREER_{t-2} + 0.334(0.086)\Delta InREER_{t-3} - 0.480(0.173) D1996 - 0.426(0.160) D1997$

$South\ Africa\ \Delta InX = -1.917(1.113) - 0.067(0.035) InX_{t-1} + 0.110(0.038) InZY_t + 0.018(0.054) InREER_t + 2.311(0.350)\Delta InZY_t - 0.126(0.060)\Delta InREER_t + 0.097(0.034) D1993 + 0.074(0.034) D1995$

$South\ Africa\ Post\ Apartheid\ \Delta InX = -0.778(1.337) - 0.195(0.057) InX_{t-1} + 0.167(0.041) InZY_t + 0.062(0.057) InREER_t + 1.992(0.375)\Delta InZY_t - 0.137(0.063)\Delta InREER_t + 0.070(0.029) D1994onward$

$Benin\ \Delta InX = -32.684(15.866) - 0.505(0.219) InX_{t-1} + 1.351(0.620) InZY_t + 0.029(0.234) InREER_t + 0.648(0.262)\Delta InX_{t-1} - 0.009(0.237)\Delta InX_{t-2} + 0.488(0.256)\Delta InX_{t-3} - 0.327(0.257)\Delta InX_{t-4} + 0.631(0.259)\Delta InX_{t-5} + 1.524(2.425)\Delta InZY_t + 2.173(2.678)\Delta InZY_{t-1} + 1.023(2.743)\Delta InZY_{t-2} + 2.827(3.010)\Delta InZY_{t-3} + 1.327(2.744)\Delta InZY_{t-4} + 3.944(3.513)\Delta InZY_{t-5} + 1.283(3.090)\Delta InZY_{t-6} - 0.707(0.549)\Delta InREER_t + 0.078(0.565)\Delta InREER_{t-1} - 0.432(0.516)\Delta InREER_{t-2} - 0.497(0.457)\Delta InREER_{t-3} - 0.664(0.482)\Delta InREER_{t-4} - 0.278(0.414)\Delta InREER_{t-5}$

$Botwana\ \Delta InX = -10.767(3.508) - 0.338(0.108) InX_{t-1} + 0.656(0.208) InZY_t - 0.534(0.305) InREER_t + 6.345(1.337)\Delta InZY_t + 0.275(0.110) D1982 + 0.274(0.102) D1983$

$Cameroon\ \Delta InX = -2.982(2.904) - 0.162(0.065) InX_{t-1} + 0.218(0.117) InZY_t - 0.080(0.111) InREER_t - 0.254(0.146)\Delta InX_{t-1} + 2.289(1.131)\Delta InZY_t + 0.301(0.103) D1980 + 0.324(0.105) D1981 + 0.399(0.105) D1984 + 0.235(0.116) D1985$

$Chad\ \Delta InX = -28.323(17.026) - 0.455(0.179) InX_{t-1} + 1.124(0.549) InZY_t + 0.574(0.428) InREER_t + 9.010(4.291)\Delta InZY_t - 7.294(4.291)\Delta InZY_{t-1} - 0.504(0.301) D1982$

$$Democratic\ Republic\ of\ Congo\ \Delta InX = -11.181(3.787) - 0.155(0.074)InX_{t-1} + 0.441(0.132)InZY_t + 0.115(0.076)InREER_t + 6.244(1.882)\Delta InZY_t - 0.070(0.111)\Delta InREER_t - 0.341(0.109)\Delta InREER_{t-1} - 0.410(0.183)D1997$$

$$Republic\ of\ Congo\ (AIC)\ \Delta InX = -2.490(1.708) - 0.372(0.086)InX_{t-1} + 0.379(0.105)InZY_t - 0.225(0.068)InREER_t + 0.378(0.126)\Delta InX_{t-1} - 0.013(0.632)\Delta InZY_t - 0.877(0.607)\Delta InZY_{t-1} - 0.976(0.628)\Delta InZY_{t-2} + 0.172(0.557)D1980 - 0.184(0.060)D1994 - 0.201(0.055)D2007$$

$$Gambia\ (AIC)\ \Delta InX = -9.292(3.974) - 0.409(0.087)InX_{t-1} + 0.490(0.137)InZY_t + 0.357(0.126)InREER_t + 0.340(0.116)\Delta InX_{t-1} + 0.216(0.127)\Delta InX_{t-2} - 2.215(1.308)\Delta InZY_t - 0.278(0.218)\Delta InREER_t - 0.245(0.111)D1994 - 0.391(0.126)D2006$$

$$Mali\ \Delta InX = -13.637(6.445) - 0.410(0.103)InX_{t-1} + 0.759(0.267)InZY_t - 0.353(0.095)InREER_t + 0.473(0.150)\Delta InREER_t + 0.503(0.133)\Delta InREER_{t-1} - 0.565(0.199)\Delta InREER_{t-2} - 0.424(0.123)\Delta InREER_{t-3} - 0.185(0.076)D1978 + 0.364(0.083)D1980 - 0.493(0.113)D1996 + 0.118(0.069)D2001$$

$$Mauritius\ \Delta InX = -2.318(3.065) - 0.098(0.085)InX_{t-1} + 0.155(0.576)InZY_t - 0.080(0.179)InREER_t + 0.868(0.789)\Delta InZY_t - 0.044(0.255)\Delta InREER_t - 0.108(0.067)D1981 - 0.010(0.062)D2000 + 0.110(0.060)D2001 - 0.153(0.061)D2002 - 0.090(0.058)D2003$$

$$Mozambique\ \Delta InX = -25.351(11.402) - 0.199(0.076)InX_t + 0.956(0.406)InZY_t - 0.089(0.058)InREER_t - 0.181(0.089)D1992 + 0.242(0.086)D2001$$

$$Namibia\ \Delta InX = -18.072(3.631) - 0.911(0.157)InX_{t-1} + 1.184(0.204)InZY_t + 0.170(0.136)InREER_t + 0.537(0.186)\Delta InX_{t-1} - 2.238(0.949)\Delta InZY_t - 1.211(0.959)\Delta InZY_{t-1} - 0.411(0.165)\Delta InREER_t - 0.082(0.177)\Delta InREER_{t-1} - 0.237(0.060)D1990 - 0.135(0.078)D1992 - 0.156(0.060)D2001$$

$$Senegal\ \Delta InX = 2.672(2.790) - 0.858(0.126)InX_{t-1} + 0.520(0.123)InZY_t - 0.085(0.108)IniREER_t - 1.800(1.029)\Delta InZY_t - 2.187(0.951)\Delta InZY_{t-1} - 2.671(1.025)\Delta InZY_{t-2} - 0.252(0.085)D1980 - 0.188(0.086)D1991 - 0.252(0.089)D1992 - 0.358(0.092)D1993$$

$$Uganda\ \Delta InX = -32.786(14.364) - 0.374(0.113)InX_{t-1} + 1.298(0.512)InZY_t - 0.004(0.105)InREER_t - 4.156(2.293)\Delta InZY_t + 0.168(0.168)\Delta InREER_t - 0.267(0.157)D1991 - 0.311(0.160)D1993$$

$$Zambia\ \Delta InX = -11.185(5.327) - 0.051(0.031)InX_{t-1} + 0.411(0.183)InZY_t - 0.520(0.143)InRPX4_t - 1.002(0.284)\Delta InX_{t-1} + 1.013(2.086)\Delta InZY_t - 6.524(2.019)\Delta InZY_{t-1} + 0.462(0.122)\Delta InRPX4_t + 0.110(0.112)\Delta InRPX4_{t-1} + 0.332(0.178)D2000 + 0.247(0.133)D2003 + 0.328(0.140)D2004 + 0.323(0.147)D2005$$

$$Zimbabwe\ \Delta InX = 224.114(80.509) - 0.526(0.113)InX_{t-1} + 7.697(2.971)InZY_t - 0.732(0.217)InRPX4_t + 0.639(0.213)\Delta InX_{t-1} + 0.385(0.220)\Delta InX_{t-2} + 0.656(0.187)\Delta InX_{t-3} - 6.335(2.255)\Delta InZY_t + 0.840(0.238)\Delta InRPX4_t + 0.608(0.214)\Delta InRPX4_{t-1} + 0.327(0.151)\Delta InRPX4_{t-2} + 0.305(0.120)\Delta InRPX4_{t-3} + 0.192(0.106)D2001 + 0.311(0.161)D2004 - 0.333(0.140)D2007 - 0.481(0.135)D2008 - 0.226(0.085)t$$

Results from OLS

$$Democratic\ Republic\ of\ Congo\ \Delta InX = -0.122(0.073) + 3.972(1.793)\Delta InZY - 0.066(0.111)\Delta InREER + 0.118(0.060)D1997onward$$

$$Gabon\ \Delta InX = -0.018(0.037) + 1.781(0.988)\Delta InZY - 0.071(0.201)\Delta InREER + 0.231(0.123)D1975 - 0.178(0.111)D2000$$

Appendix J

Results: Import demand function controlling for Apartheid South Africa

	Long run Income elasticity of demand for imports, π		Price elasticity of demand for imports, ψ		ARDL	SBC	R^2	Adjusted R^2	Bounds F test	Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (P value)	Breusch-Godfrey test for serial correlation (P value)	Ramsey regression specification-error test for omitted variables (P value)
South Africa	2.077***	(0.264)	-0.691*	(0.375)	(1 1 0)	-129.922	0.781	0.751	12.078***	0.702	0.155	0.335
South Africa (trend)	0.955*	(0.548)	-1.080*	(0.555)	(1 2 2)	-126.727	0.791	0.746	4.496	0.522	0.116	0.601
South Africa (trend)	0.819	(0.59)	-1.064	(0.399)	(1 1 0)	-131.366	0.803	0.77	10.590***	0.776	0.263	0.535
South Africa Post-Apartheid[118]	1.811	(0.263)	-0.776*	(0.313)	(1 1 0)	-127.77	0.789	0.753	12.110***	0.746	0.153	0.414
South Africa Post-Apartheid (trend)	0.981	(0.641)	-1.072*	(0.561)	(1 2 2)	-122.783	0.791	0.74	3.136	0.525	0.108	0.5994

*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

[118] For South Africa, we estimate the import demand function using two different specifications; in the second specification we control for apartheid by including a dummy variable which takes the value of 1 for the period 1994 onwards and zero otherwise. We include a trend as unit root tests provided evidence that some of the variables are trend stationary.

For South Africa we use the Wald test to formally determine if the income and price elasticities are statistically significantly different for the specification that controls for apartheid. The two estimates for the income elasticities of demand are 2.077 for the former and 1.811 for the latter. The F statistic and P value from the Wald test (H_0: 2.077 = 1.811) were, 1.01 and 0.319 respectively. The two estimates for the price elasticities are -0.691 and -0.776 receptively. The F statistic and P value from the Wald test (H_0: -0.691 = -0.776) were, 0.05 and 0.821 respectively.

The results from the unit root tests indicated that the South African GDP series is trend stationary. We therefore modify to include a trend and test if the two specifications differ. We test if the income and price elasticities of demand are statistically different from each other. The two respective income elasticities of demand were 0.819 and 0.981 respectively. The F statistic and P value from the Wald test (H_0: 0.819 = 0.981) were 0.07 and 0.786 respectively while the price elasticities of demand were -1.064 and -1.072 respectively. The corresponding F statistic and P value from the Wald test (H_0: -1.064 = -1.072) were 0.00 and 0.983 respectively.

We also test if the specification with a trend differs from the specification without a trend without controlling for apartheid, the income elasticities were 2.077 and 0.819. The F statistic and P value from the Wald test (H_0: 0.819 = 2.077) were 4.54 and 0.039. The price elasticities of demand were -0.691 and -1.064. The F statistic and P value for the Wald test (H_0: -1.064 = -0.691) were 0.87 and 0.357. We therefore continue with the specification which includes a trend but does not control for apartheid.

Export demand function controlling for Apartheid

	Income elasticity of demand for exports, ε		Price elasticity of demand for exports, η		ARDL	SBC	R^2	Adjusted R^2	Bounds F test	Breusch-Pagan/Cook-Weisberg test for heteroscedasticity P value	Breusch-Godfrey test for serial correlation P value	Ramsey regression specification-error test for omitted variables P value
South Africa	1.637**	(0.629)	0.268	(0.839)	(1 1 1)	-175.118	0.598	0.531	6.253**	0.095*	0.234	0.015**
South Africa Post-Apartheid[119]	0.854***	(0.20)	0.317	(0.306)	(1 1 1)	-172.898	0.545	0.482	6.415***	0.086*	0.752	0.049**

*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

[119] For South Africa, we test if the income and price elasticities of demand for exports differs when controlling for apartheid using the Wald test. The income elasticity of demand was 1.637 and 0.854 when controlling for apartheid. The F statistic and P value were 1.55 and 0.220 respectively. The price elasticity of demand was 0.268 and 0.317 when controlling for apartheid. The F statistic and P value were 0.00 and 0.954 respectively. We therefore continue with the specification which does not control for apartheid.

Appendix K

The balance of payments constrained growth rate for the sub-periods 1960 to 1980

					Average				Start			
Period	Country	Actual	y_B	$*y_B$	y_{BSDA}	y_{BSDAR}	$*y_{BSDARTOT}$	$y_{BSDARTOT}$	y_{BSDA}	y_{BSDAR}	$*y_{BSDARTOT}$	$y_{BSDARTOT}$
1960-1980	Sudan	2.911	3.458	2.187	3.433	2.382	-10.092	3.935	3.443	2.455	-9.913	4.122
1960-1980	Sudan (OLS)	2.911	3.437		3.416	2.369		3.914	3.424	2.441		4.099
1960-1980	Kenya	6.77	4.284	5.962	4.292	1.155	3.273	1.277	4.304	2.912	4.870	3.044
1960-1980	Benin	3.02	10.625	11.300	8.610	7.937	9.278	8.724	8.681	8.353	9.675	9.120
1960-1980	Cameroon	4.705	4.227		4.173	2.721	-0.811	3.589	4.207	3.649	0.177	4.473
1960-1980	Chad	-0.408	3.446		26.566	26.801	0.635	28.059	15.906	15.841	0.352	16.542
1960-1980	Congo, Dem. Rep.	2.026	1.540	6.274	1.888	-0.469	6.051	-0.091	2.299	1.737	9.164	1.998
1960-1980	Congo, Dem. Rep.[120] (OLS)	2.026	1.415	8.089	1.762	-0.436	8.679	-0.085	2.187	1.651	12.352	1.899
1960-1980	Congo, Rep.	5.686	9.328	3.314	10.350	9.626	2.792	9.732	6.273	5.502	1.532	5.730
1960-1980	Gabon	8.504	9.403		10.580	10.417		10.232	10.638	10.405		10.486
1960-1980	Gabon (OLS)	8.504	12.246	8.781	12.112	11.654	8.875	12.300	12.106	11.860	8.997	12.469
1966-1980	Gambia	5.224	9	11.374	-32.518	-26.543	-19.818	-15.844	-13.795	-13.523	-9.843	-8.105
1967-1980	Mali	4.309	4.012	3.806	2.212	2.046	4.401	5.814	1.851	1.712	4.502	5.684
1960-1980	Senegal	2.014	2.474	2.642	2.421	1.378	2.096	1.926	2.410	2.214	2.934	2.769
1967-1980	Sierra Leone	3.526	-1.382		-1.322	-1.543		-2.644	-1.226	-1.328		-2.478
1960-1980	Togo	6.741	10.088		8.078	7.666		7.690	6.309	6.074		6.103
1960-1980	Zambia	2.816	0.315	8.509	0.215	-1.343	4.604	-1.544	0.214	-0.301	5.277	-0.490

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered.
y_B, is the "weak" original version of the balance of payments constrained growth model
y_B, is the "strong" original version of the balance of payments constrained growth model
y_{BSDA}, is the balance of payments constrained growth with sustainable debt accumulation
y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad
$*y_{BSDARTOT}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports
$y_{BSDARTOT}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)
OLS indicates the growth rates that have been estimated using the import and export demand functions derived from OLS

[120] Both the export and import demand function are estimated with OLS.

The balance of payments constrained growth rate for the sub-periods 1980 to 2014

					Average				Start			
Period	Country	Actual	y_B	$*\ y_B$	y_{BSDA}	y_{BSDAR}	$*\ y_{BSDARTOT}$	$y_{BSDARTOT}$	y_{BSDA}	y_{BSDAR}	$*\ y_{BSDARTOT}$	$y_{BSDARTOT}$
1980-2014	Kenya	3.786	4.480	3.616	4.484	6.599	4.443	5.677	4.484	7.092	4.790	6.110
1980-2014	South Africa	2.357	3.218	4.981	3.205	3.041	4.903	3.087	3.205	3.041	4.929	3.119
1980-2012	Sudan	4.642	7.485	2.180	7.520	5.004	-45.990	13.701	7.611	-2.360	-55.923	9.474
1980-2014	Sudan (OLS)	4.642	7.439		7.468	4.969		13.604	7.546	-2.338		9.383
1980-2014	Benin	4.172	5.542	6.792	5.163	4.939	6.270	5.051	4.513	4.283	5.517	4.456
1980-2014	Cameroon	3.148	3.236		3.295	3.600	-0.293	3.244	3.411	3.905	-0.234	3.572
1980-2005	Chad	6.955	23.745		90.000	94.035	-26.061	69.232	164.423	166.438	-47.811	118.928
1980-2014	Congo, Dem. Rep.	0.998	3.979	2.718	4.409	2.213	0.386	1.870	4.371	-2.072	-4.097	-2.458
1980-2014	Congo, Dem. Rep. (OLS)	0.998	3.655	3.504	4.081	2.039	1.545	1.723	4.043	-1.891	-2.437	-2.242
1980-2014	Congo, Rep.	3.956	2.790	1.992	3.368	2.781	1.932	2.209	3.442	2.816	2.013	2.297
1980-2014	Gabon	2.284	1.152		1.303	0.830		0.718	1.253	0.588		0.440
1980-2014	Gabon (OLS)		1.500	5.281	1.483	0.949	3.983	0.091	1.488	0.705	3.494	-0.482
1980-2013	Gambia	3.595	8.951	7.354	30.827	41.508	-41.249	-7.233	-5.411	-4.843	10.567	6.683
1980-2007	Mali	3.607	3.672	2.672	2.421	2.304	0.921	1.029	2.002	1.926	0.476	0.565
1980-2014	Senegal	3.384	3.577	1.588	3.425	3.299	-0.319	1.696	3.375	3.153	-0.736	1.331
1980-2014	Sierra Leone	3.09	5.929		4.635	3.372		4.347	3.787	2.850		3.903
1980-2014	Togo	2.437	2.611		2.125	1.689		1.581	2.160	1.580		1.472
1980-2013	Zambia	3.835	3.075	5.139	2.725	0.215	3.338	1.201	2.380	0.246	3.058	1.238

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered.

y_B, is the "weak" original version of the balance of payments constrained growth model

y_B, is the "strong" original version of the balance of payments constrained growth model

y_{BSDA}, is the balance of payments constrained growth with sustainable debt accumulation

y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad

$*\ y_{BSDARTOT}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports

$y_{BSDARTOT}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)

OLS indicates the growth rates that have been estimated using the import and export demand functions derived from OLS

Appendix L

Results from the Wald test for the equality of the estimated income elasticity of demand, $\hat{\pi}$, and the hpothetical income elsasticity of demand, π_H, 1960 to 1980

Period	Country	$\hat{\pi}$	π_{HB}	$*\pi_{HB}$	π_{HBSDA}	π_{HBSDAR}	$*\pi_{HBSDART}$	$\pi_{HBSDART}$	π_{HBSDA}	π_{HBSDAR}	$*\pi_{HBSDART}$	$\pi_{HBSDART}$
1960-	Kenya	0.986	0.624	0.868	0.664	0.372	0.603	0.385	0.716	0.596	0.794	0.610
1980	F statistic		2.62	0.31	2.29	8.34***	3.25*	7.99***	1.61	3.37*	0.82	3.13*
	P value		0.112	0.581	0.137	0.006	0.078	0.007	0.210	0.073	0.371	0.083
1964-	Sudan[121]	0.957	1.137	0.719	1.164	0.755	-4.002	1.348	1.152	0.795	-3.598	1.387
1980	F statistic		0.83	1.46	1.10	1.05	633.17***	3.93**	0.97	0.68	534.2***	4.75**
	P value		0.367	0.232	0.300	0.309	0.000	0.053	0.328	0.414	0.000	0.034
1964-	Sudan											
1980	(OLS)	0.963	1.137		1.164	0.755		1.348	1.152	0.795		1.387
	F statistic		0.09		0.13	0.14		0.47	0.11	0.09		0.57
	P value		0.759		0.723	0.711		0.497	0.739	0.765		0.455
1960-	Benin	1.142	4.017	4.273	2.047	1.928	2.142	2.054	2.077	2.018	2.235	2.143
1980	F statistic		691.44***	820.09***	68.45***	52.63***	83.59***	69.52***	73.07***	64.23***	99.87***	83.76***
	P value		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1960-	Cameroon	1.379	1.239		1.228	0.845		1.079	1.235	1.079		1.313
1980	F statistic		2.57		2.99	37.12***		11.74***	2.72	11.74		0.58
	P value		0.117		0.092	0.000		0.001	0.107	0.001		0.452
1960-	Chad	0.656	-5.541		-1.459	-1.411	0.576	-1.506	-1.623	-1.574	0.551	-1.670
1980	F statistic		1555***		181.32***	173.19***	0.27	189.47	210.52***	201.57	0.45	219.29***
	P value		0.000		0.000	0.000	0.610	0.000	0.000	0.000	0.506	0.000
1960-	Congo,											
1980	Dem. Rep.	2.179	1.656	6.748	1.996	-0.958	7.240	-0.483	2.685	1.653	15.187	2.129
	F statistic		0.17	13.01***	0.02	6.13**	15.97***	4.42**	0.16	0.17	105.47***	0.00
	P value		0.682	0.001	0.885	0.018	0.000	0.042	0.619	0.680	0.000	0.968
1960-	Congo,											
1980	Dem. Rep.											
	(OLS)	2.372	1.657	9.471	1.996	-0.958	11.371	-0.483	2.685	1.653	22.172	2.129
	F statistic		1.40	137.54***	0.39	30.28***	221.02***	22.26***	0.27	1.41	1070.04***	0.16
	P value		0.243	0.000	0.536	0.000	0.000	0.000	0.608	0.240	0.000	0.689

[121] For Sudan import and export demand function from ARDL.

1960-	Congo,											
1980	Rep.	1.483	2.433	0.864	3.056	2.778	0.532	2.813	1.574	1.455	0.852	1.489
	F statistic		10.61***	4.51**	29.09***	19.71***	10.65***	20.79***	0.10	0.01	4.69**	0.00
	P value		0.005	0.049	0.000	0.000	0.004	0.000	0.760	0.923	0.045	0.984
1960-	Gabon	1.275	1.409		1.846	1.717		1.740	1.888	1.814		1.837
1980	F statistic		0.74		13.52***	8.09***		8.96***	15.58**	12.04***		13.10***
	P value		0.395		0.000	0.006		0.004	0.000	0.001		0.000
1960-	Gabon[122]											
1980	(OLS)	0.979	1.409	1.010	1.846	1.717	1.045	1.869	1.888	1.814	1.101	1.966
	F statistic		2.28	0.01	9.29***	6.73***	0.05	9.79***	10.21***	8.61***	0.18	12.04***
	P value		0.137	0.915	0.003	0.012	0.819	0.003	0.002	0.005	0.673	0.001
1966-	Gambia	0.475	0.818	1.034	0.916	0.858	0.777	0.729	0.927	0.921	0.834	0.792
1980	F statistic		3.13*	8.32***	5.18**	3.91**	2.43	1.72	5.44**	5.30**	3.43*	2.68
	P value		0.085	0.006	0.029	0.056	0.128	0.198	0.025	0.027	0.072	0.110
1967-	Mali	2.195	2.043	1.939	1.418	1.361	2.228	2.749	1.331	1.287	2.262	2.675
1980	F statistic		0.02	0.06	0.53	0.61	0.00	0.27	0.65	0.72	0.00	0.20
	P value		0.887	0.812	0.473	0.441	0.975	0.608	0.425	0.402	0.950	0.657
1960-	Senegal	1.107	1.359	1.452	1.294	0.823	1.143	1.068	1.282	1.195	1.512	1.439
1980	F statistic		9.60***	18.01***	5.28**	12.28***	0.19	0.24	4.62**	1.16	24.83***	16.18***
	P value		0.003	0.000	0.027	0.001	0.664	0.629	0.038	0.287	0.000	0.000
1967-	Sierra											
1980	Leone	2.31	-0.905		-0.764	-0.865		-1.555	-0.557	-0.601		-1.291
	F statistic		10.82***		9.89***	10.55***		15.64***	8.61***	8.87***		13.57***
	P value		0.002		0.003	0.002		0.000	0.005	0.005		0.000
1960-	Togo											
1980	(OLS)	1.608	2.406		1.848	1.772		1.777	1.544	1.510		1.514
	F statistic		2.59		0.23	0.11		0.10	0.02	0.04		0.03
	P value		0.114		0.632	0.743		0.752	0.897	0.843		0.859
1960-	Zambia	4.562	0.510	13.786	0.692	-1.077	6.987	-1.329	0.693	0.070	8.108	-0.202
1980	F statistic		3.49*	18.08***	3.18*	6.76**	1.25	7.37**	3.18*	4.29*	2.67	4.82**
	P value		0.084	0.001	0.097	0.022	0.283	0.017	0.097	0.058	0.126	0.046

[122] For Gabon both the import and export demand function are estimated using OLS.

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered.
π_{HB}, is the hypothetical income elasticity of demand from the original "weak" version of the balance of payments constrained growth model
$*\,\pi_{HB}$, *is the hypothetical income elasticity of demand from the original "strong" version of the balance of payments constrained growth model*
π_{HBSDA}, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation
π_{HBSDAR}, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation and interest payments abroad
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$\pi_{HBSDART}$, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Results from the Wald test for the equality of the estimated income elasticity of demand, $\hat{\pi}$, *and the hpothetical income elsasticity of demand,* π_H, $1980\ to\ 2014$

					Average				Start			
Period	Country	$\hat{\pi}$	π_{HB}	$*\,\pi_{HB}$	π_{HBSDA}	π_{HBSDAR}	$*\,\pi_{HBSDART}$	$\pi_{HBSDART}$	π_{HBSDA}	π_{HBSDAR}	$*\,\pi_{HBSDART}$	$\pi_{HBSDART}$
1980-	Kenya	0.986	1.166	0.941	1.157	1.471	1.099	1.312	1.158	1.521	1.148	1.362
2014	F statistic		0.72	0.04	0.65	5.21**	0.28	2.35	0.65	6.33**	0.58	3.13*
	P value		0.401	0.833	0.425	0.027	0.597	0.132	0.422	0.015	0.450	0.083
1980-	South Africa	0.955	1.304	2.018	1.344	1.246	2.089	1.280	1.333	1.251	2.068	1.284
2014	F statistic		0.40	3.75**	0.50	0.28	4.27**	0.35	0.47	0.29	4.11**	0.36
	P value		0.528	0.059	0.482	0.598	0.045	0.557	0.494	0.592	0.049	0.552
1980-	Sudan	0.957	1.543	0.449	1.493	1.023	-8.216	2.598	1.397	0.025	-7.106	1.600
2014	F statistic		8.83***	6.65***	5.34**	0.11	2166***	69.29***	4.97**	22.38***	1673***	10.63***
	P value		0.004	0.013	0.025	0.740	0.000	0.000	0.030	0.000	0.000	0.002
1980-	Sudan (OLS)	0.963	1.543		1.493	1.023		2.598	1.397	0.025		1.600
2014	F statistic		1.06		0.89	0.01		8.44***	0.59	2.79		1.28
	P value		0.308		0.351	0.916		0.005	0.444	0.101		0.263
1980-	Benin	1.142	1.517	1.859	1.325	1.277	1.512	1.297	1.182	1.154	1.295	1.174
2014	F statistic		11.73***	42.95***	2.79*	1.51	11.42***	2.00	0.13	0.01	1.94	0.08
	P value		0.001	0.000	0.105	0.228	0.002	0.168	0.720	0.917	0.173	0.775
1980-	Cameroon	1.379	1.417		1.446	1.572	-0.096	1.420	1.513	1.726	-0.170	1.573
2014	F statistic		0.18		0.57	4.80**	282.75**	0.21	2.31	15.57***	311.82***	4.85**

	P value		0.673		0.454	0.034	0.000	0.648	0.137	0.000	0.000	0.033
1980-	Chad	0.656	2.239		1.515	1.507	0.333	1.264	1.471	1.470	0.376	1.227
2014	F statistic		101.36***		29.81***	29.26***	4.25**	14.92***	26.84***	26.77***	3.20*	13.16***
	P value		0.000		0.000	0.000	0.049	0.000	0.000	0.000	0.085	0.001
1980-	Congo, Dem.											
2012	Rep.	2.179	8.688	5.935	10.379	4.929	0.794	4.153	10.218	-4.005	-8.083	-4.081
	F statistic		26.41***	8.79***	41.91***	4.71**	1.20	2.43	40.28***	23.84***	65.64***	24.43***
	P value		0.000	0.005	0.000	0.036	0.281	0.127	0.000	0.000	0.000	0.000
1980-	Congo, Dem.											
2012	Rep.(OLS)	2.372	8.688	8.330	10.379	4.929	3.716	4.153	10.218	-4.005	-5.211	-4.781
	F statistic		108.87***	96.87***	174.97***	17.84***	4.93**	8.65***	168.01***	111.02***	156.98***	139.68***
	P value		0.000	0.000	0.000	0.000	0.031	0.005	0.000	0.000	0.000	0.000
1980-	Congo, Rep.	1.483	1.046	0.746	1.097	0.746	0.213	0.387	1.110	0.694	0.138	0.335
2014	F statistic		2.25	6.40**	1.76	6.40**	18.98***	14.14***	1.64	7.33**	21.19***	15.51***
	P value		0.153	0.022	0.203	0.022	0.000	0.001	0.218	0.015	0.000	0.001
1980-	Gabon	1.275	0.643		0.226	-0.225		-0.341	0.429	-0.049		-0.165
2014	F statistic		16.64***		45.81***	93.63***		108.67***	29.81***	72.96***		86.30***
	P value		0.000		0.000	0.000		0.000	0.000	0.000		0.000
1980-	Gabon[123] (OLS)	0.979	0.634	2.263	0.226	-0.225	2.513	-1.00	0.429	-0.049	1.767	-0.823
2014	F statistic		1.48	20.38	7.03***	17.95***	29.78***	48.48***	3.75*	13.09***	7.67***	40.20
	P value		0.230	0.000	0.010	0.000	0.000	0.000	0.058	0.000	0.008	0.000
1980-	Gambia	0.475	1.183	0.971	1.111	1.076	-0.236	0.303	1.054	1.041	0.008	0.268
2013	F statistic		13.35***	6.55**	10.77***	9.62***	13.46***	0.79	8.93***	8.53***	5.81**	1.14
	P value		0.000	0.015	0.002	0.003	0.000	0.380	0.005	0.006	0.021	0.292
1980-	Mali	2.195	2.235	1.626	1.633	1.588	0.944	0.995	1.487	1.462	0.829	0.868
2007	F statistic		0.00	0.28	0.28	0.32	1.37	1.26	0.44	0.47	1.63	1.54
	P value		0.970	0.598	0.603	0.574	0.251	0.271	0.513	0.498	0.211	0.224
1980-	Senegal	1.107	1.170	0.519	1.116	1.088	0.288	0.734	1.105	1.062	0.305	0.707
2014	F statistic		0.59	52.55***	0.01	0.06	101.91***	21.17***	0.00	0.31	97.72***	24.34***
	P value		0.446	0.000	0.916	0.811	0.000	0.000	0.975	0.578	0.000	0.000

[123] For Gabon both the import and export demand function are estimated using OLS.

1980-2014	Sierra Leone	2.31	4.433		3.300	2.482		3.080	2.718	2.174		2.771
	F statistic		4.71**		1.02	0.03		0.62	0.17	0.02		0.22
	P value		0.036		0.318	0.862		0.436	0.679	0.889		0.640
1980-2014	Togo (OLS)	1.608	1.723		1.450	1.237		1.183	1.465	1.178		1.124
	F statistic		0.05		0.10	0.56		0.64	0.08	0.75		0.83
	P value		0.818		0.750	0.457		0.426	0.773	0.390		0.365
1980-2014	Zambia	4.562	3.658	6.114	3.283	0.988	4.071	1.961	2.935	1.038	3.799	2.011
	F statistic		0.17	0.51	0.35	2.71	0.05	1.44	0.56	2.64	0.12	1.38
	P value		0.683	0.487	0.565	0.123	0.824	0.251	0.466	0.128	0.730	0.260

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered.

π_{HB}, is the hypothetical income elasticity of demand from the original "weak" version of the balance of payments constrained growth model

$*\ \pi_{HB}$, *is the hypothetical income elasticity of demand from the original "strong" version of the balance of payments constrained growth model*

π_{HBSDA}, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation

π_{HBSDAR}, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation and interest payments abroad

$*\ \pi_{HBSDART}$, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports

$\pi_{HBSDART}$, is the hypothetical income elasticity of demand from the balance of payments constrained growth model with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)

*** Indicates significance at the 99% level

** Indicates significance at the 95% level

* Indicates significance at the 90% level

Appendix M

Regression results of the balance of payments constrained growth, y_B, on the actual growth rate

	Dependent variable	Constant, α	Coefficient on the actual growth rate, β	R^2	F statistic	Wald test 1 (β=1) P value	Wald test 2 (α=0) P value
	y_B	1.325 (1.881)	0.944** (0.453)	0.178	4.34**	0.903	0.489
	y_B		1.247*** (0.138)	0.795	81.74***	0.086*	
	$* y_B$	15.879** (5.937)	-2.219 (1.432)	0.146	2.40	0.041**	0.018**
	$* y_B$		1.392** (0.567)	0.286	6.03**	0.499	
Average	y_{BSDA}	9.529 (14.675)	0.205 (3.535)	0.000	0.00	0.824	0.523
	y_{BSDA}		2.391** (1.074)	0.190	4.95**	0.209	
	y_{BSDAR}	10.971 (20.166)	0.316 (4.827)	0.000	0.00	0.888	0.592
	y_{BSDAR}		2.810* (1.482)	0.152	3.60*	0.236	
	$* y_{BSDART}$	7.195 (26.454)	-2.395 (6.384)	0.010	0.14	0.603	0.789
	$* y_{BSDART}$		-0.758 (2.061)	0.008	0.14	0.407	
	y_{BSDART}	2.258 (11.417)	0.419 (2.750)	0.001	0.02	0.835	0.845
	y_{BSDART}		0.937 (0.828)	0.057	1.28	0.940	
Start	y_{BSDA}	5.357 (10.116)	0.129 (2.437)	0.000	0.00	0.724	0.602
	y_{BSDA}		1.357* (0.738)	0.138	3.38*	0.633	
	y_{BSDAR}	5.398 (10.600)	0.107 (2.537)	0.000	0.00	0.728	0.616
	y_{BSDAR}		1.334* (0.778)	0.128	2.94*	0.671	
	$* y_{BSDART}$	16.331 (5.860	-2.430 (1.414)	0.174	2.95*	0.029**	0.014**
	$* y_{BSDART}$		1.285** (0.567)	0.254	5.12**	0.622	
	y_{BSDART}	4.912 (6.835)	0.237 (1.646)	0.001	0.02	0.648	0.480
	y_{BSDART}		1.363** (0.501)	0.260	7.39**	0.476	

Note: Start refers to the start of period value for the share of exports in import ratio and the share of interest payments in imports ratio. Average refers to the average value for these two ratios for the period considered.
Standard errors are in parenthesis
y_B, is the "weak" original version of the balance of payments constrained growth model
$* y_B$, is the "strong" original version of the balance of payments constrained growth model

y_{BSDA}, is the balance of payments constrained growth with sustainable debt accumulation
y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad
$* \, y_{BSDART}$, is the balance of payments constrained growth with sustainable debt accumulation, interest payments abroad and the terms of trade interacted with the price elasticities of demand for imports and exports
y_{BSDART}, is the balance of payments constrained growth with sustainable debt accumulation, interest payments and the terms of trade (only the income and price elasticities from the import demand function are included)
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Appendix N

Summary of results for, y_{BSDAR} and, y 1991 to 2014

	5 year average	
	y_{BSDAR}	y_{BSDAR}
$y_{BSDAR_{t-1}}$	-0.251***	0.534
	(0.019)	(0.362)
$y_{BSDAR_{t-2}}$	-0.288***	0.495
	(0.019	(0.366)
$y_{BSDAR_{t-3}}$		
y_{t-1}	-1.380*	-10.898
	(0.736)	(44.016)
y_{t-2}	1.735	50.053
	(1.098)	(65.012)
Trend		9.396
		(64.204)
	y	y
$y_{BSDAR_{t-1}}$	0.0017***	0.002**
	(0.0006)	(0.0008)
$y_{BSDAR_{t-2}}$	0.0041***	0.004***
	(0.0006)	(0.0008)
$y_{BSDAR_{t-3}}$		
y_{t-1}	0.326***	0.303*
	(0.112)	(0.179)
y_{t-2}	-0.337***	-0.048
	(0.121)	(0.116)
Trend		0.581***
		(0.203)
Lag order	2	2
Instrument	5	3
MBIC	-28.606	-9.269
MAIC	-13.056	-0.634
MQIC	-17.680	-4.036
J statistic	10.943	7.365
J statistic P value	0.533	0.117
No of observations	27	64
No of cross sections	15	20
LM test for autocorrelation (P value)		
Stability condition	Stable	Not stable
Panel Granger Causality (P values)		
$y \rightarrow y_{BSDAR}$	0.148	0.739
$y_{BSDAR} \rightarrow y$	0.000***	0.000***

Note: Standard errors are in parenthesis
The stability graphs can be seen in Appendix Q
y_{BSDAR}, is the balance of payments constrained growth with sustainable debt accumulation and interest payments abroad
*** Indicates significance at the 99% level
** Indicates significance at the 95% level
* Indicates significance at the 90% level

Appendix O

Summary of results from panel unit root tests

Variable	N	Statistic	MW-ADF	MW-ADF trend	MW-ADF demean	MW-PP	MW-PP trend	MW-PP demean
Labour force in efficiency units, lfe, 1991-2014	22	Inverse χ^2	196.529	172.755	206.480	379.393	334.532	376.460
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse-normal	-9.727	-8.591	-10.060	-15.566	-14.219	-15.377
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse logit	-11.401	-9.829	-12.011	-22.313	-19.629	-22.121
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Growth in labour productivity, 1990-2014	31	Inverse χ^2	255.474	230.710	274.417	503.433	462.695	532.771
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse-normal	-10.533	-9.292	-11.247	-17.675	-16.422	-18.385
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse logit	-12.351	-10.752	-13.315	-24.914	-22.808	-26.372
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Growth in exports, x, 1960-2014	22	Inverse χ^2	464.333	390.880	440.295	776.706	687.834	747.828
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse-normal	-18.259	-16.262	-17.785	-24.982	-23.191	-24.431
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse logit	-27.376	-22.961	-25.977	-45.850	-40.599	-44.146
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Growth in income, y, 1960-2014	22	Inverse χ^2	325.688	281.451	320.303	623.275	567.834	633.403
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse-normal	-14.452	-12.871	-14.456	-21.510	-20.274	-21.880
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse logit	-19.197	-16.541	-18.884	-36.788	-33.513	-37.389
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
y_{BSDAR} 1971-2013	21	Inverse χ^2	335.941	281.686	394.976	719.841	646.167	764.028
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		Inverse-normal	-15.398	13.379	-16.992	-24.160	-22.391	-25.339

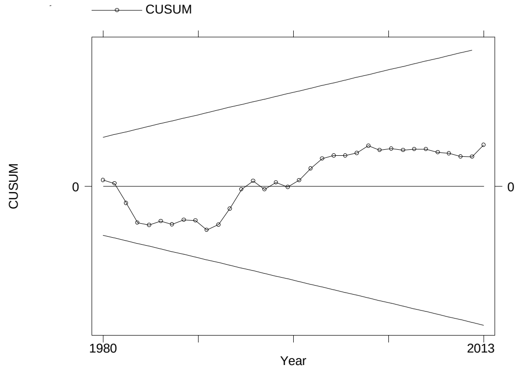
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Inverse logit	-20.889	-16.973	-23.861	-44.107	-39.050	-46.174
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

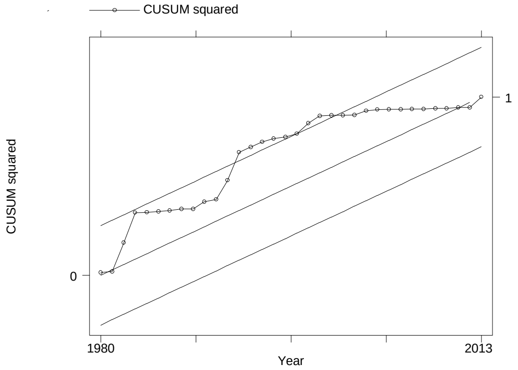
Note: P values are in parenthesis

Appendix P

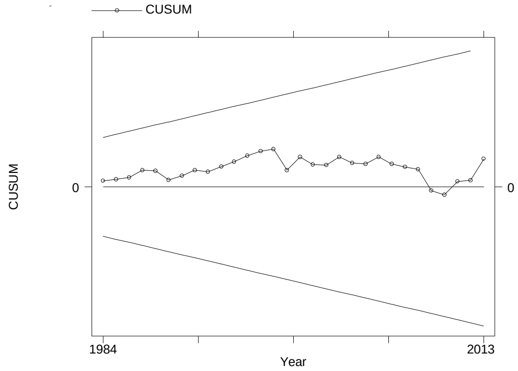
The CUSUM and CUSUM squared graphs from the import demand and export demand functions ordered by country.

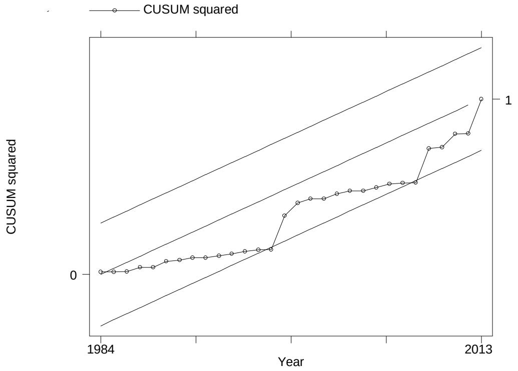
Benin import demand function



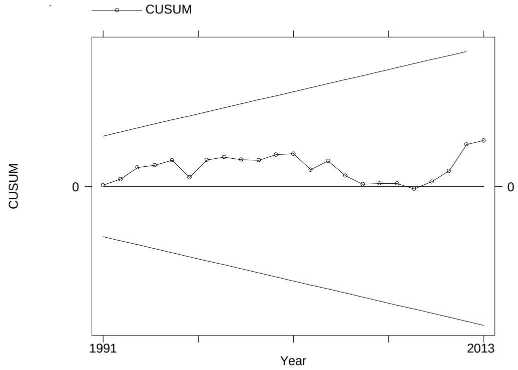


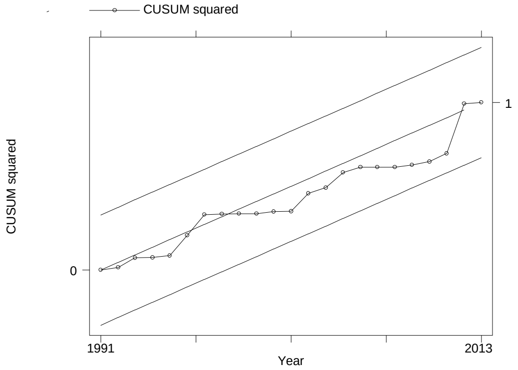
Botswana export demand function



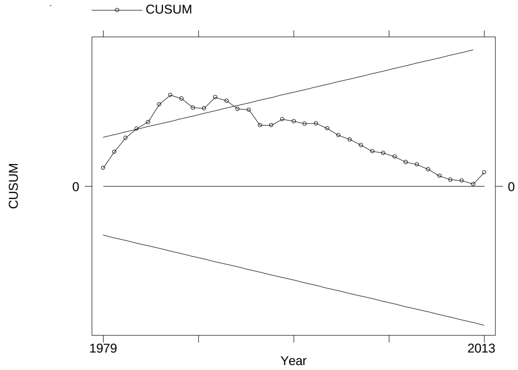


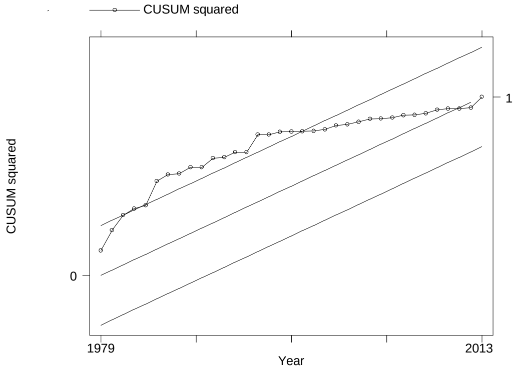
Botswana import demand function



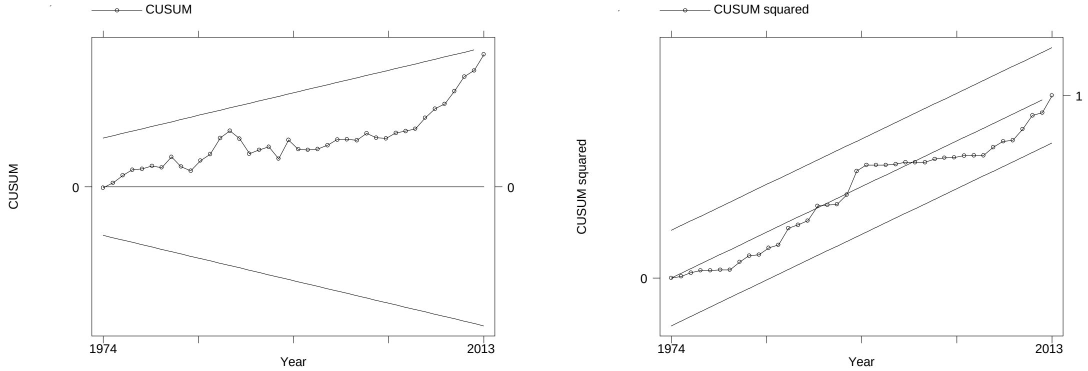


Cameroon export demand function

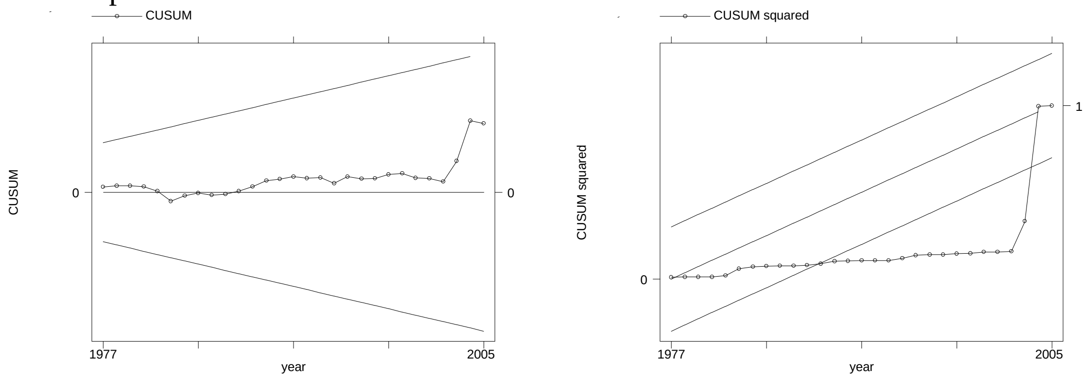




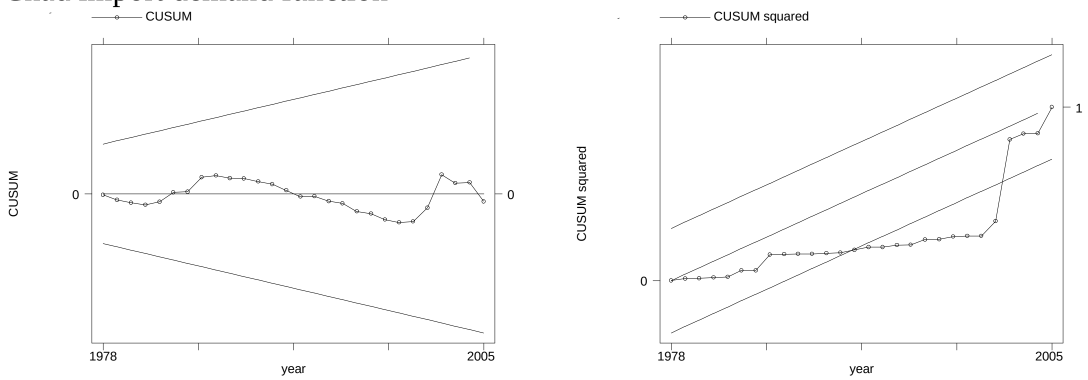
Cameroon import demand function



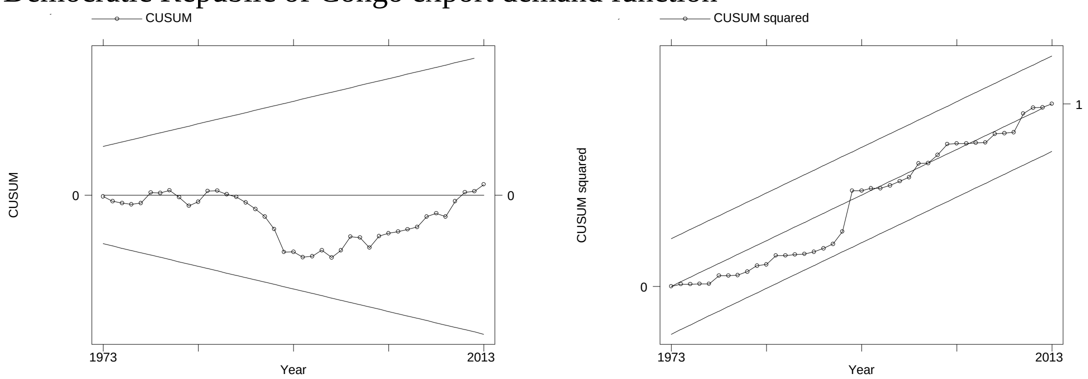
Chad export demand function



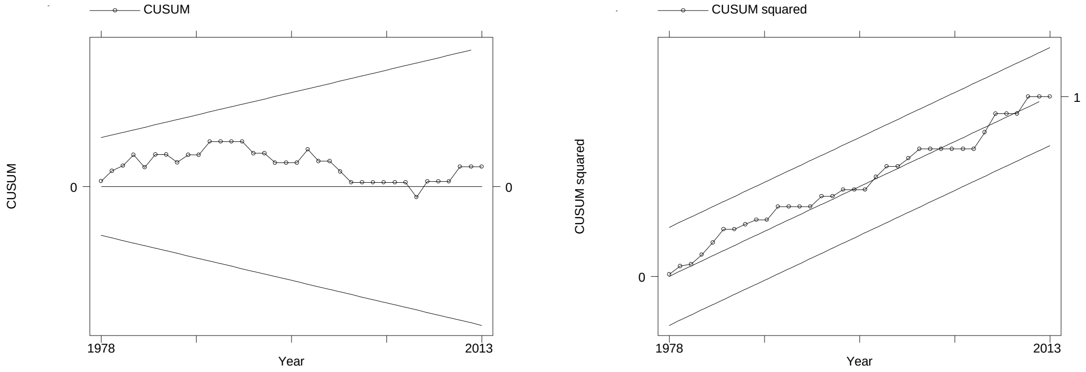
Chad import demand function



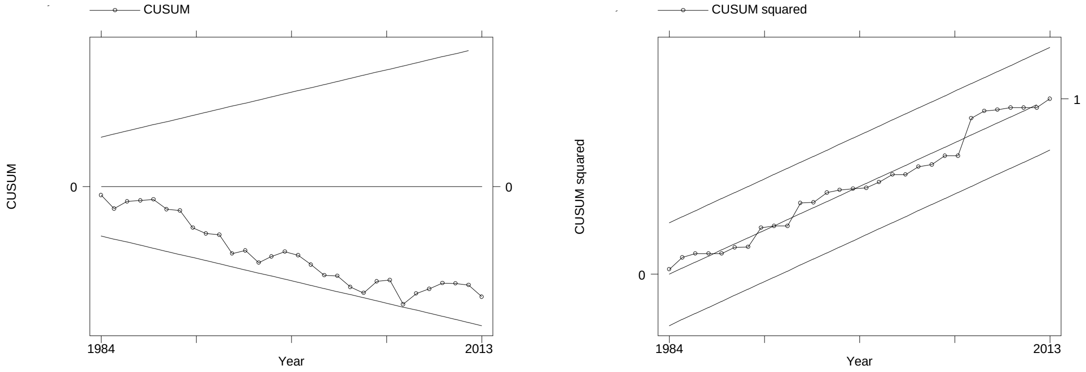
Democratic Republic of Congo export demand function



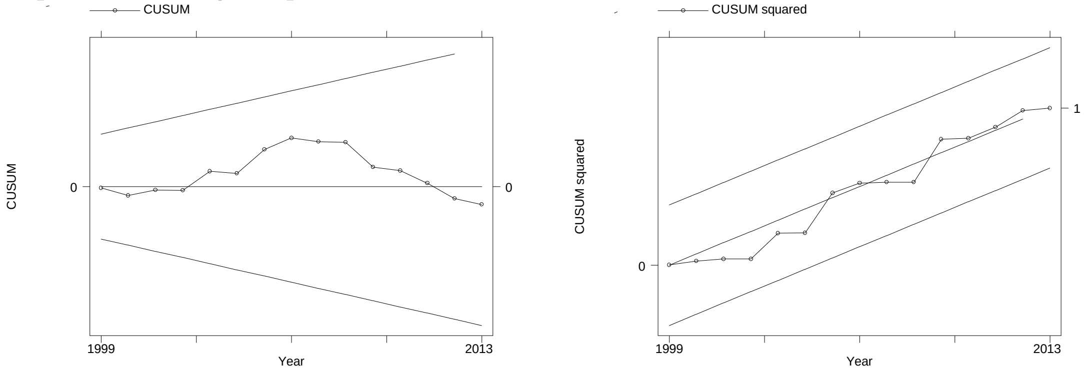
Democratic Republic of Congo import demand function



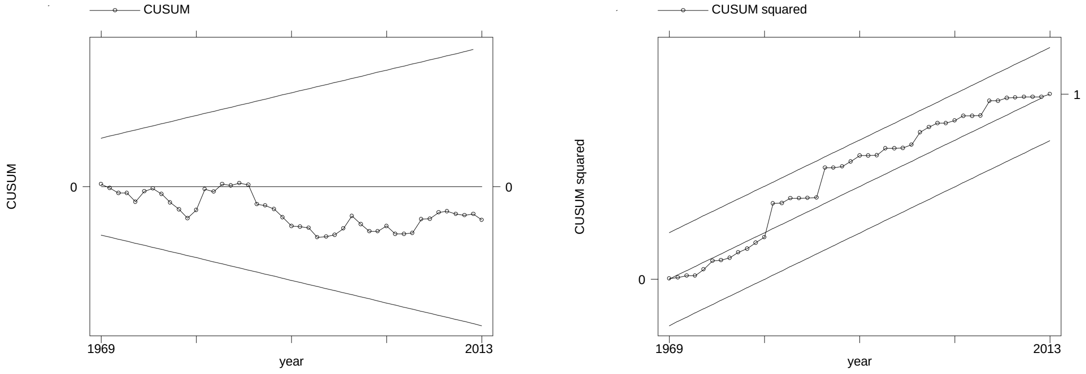
Republic of Congo export demand function



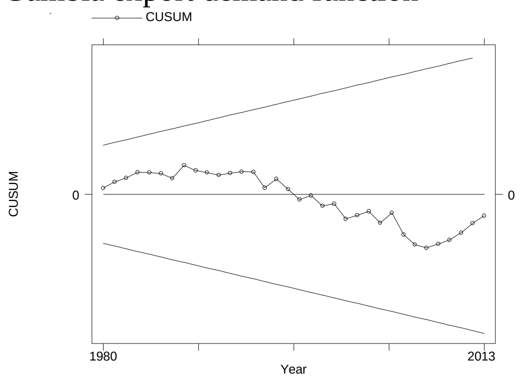
Republic of Congo import demand function

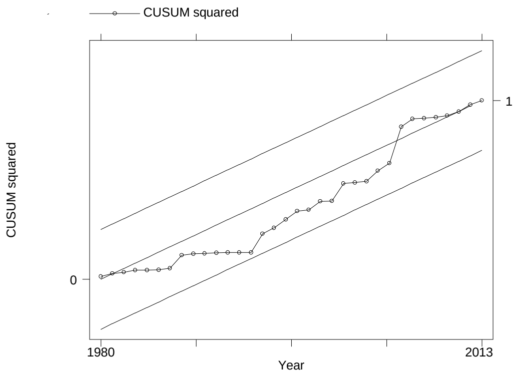


Gabon import demand function

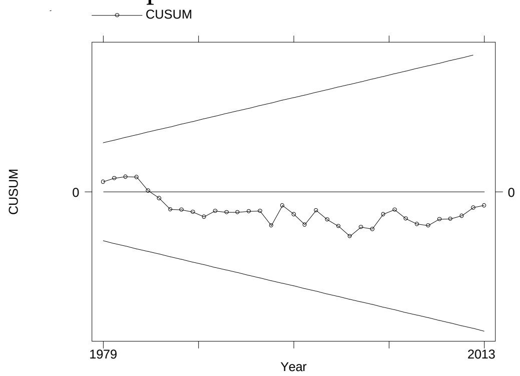


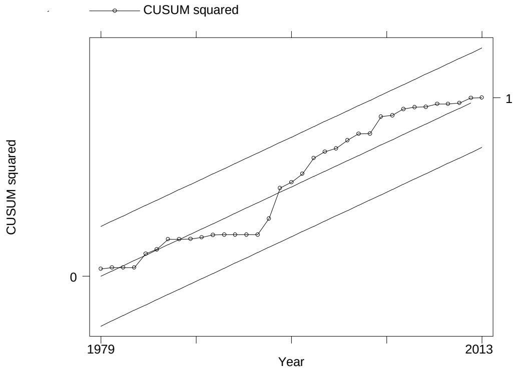
Gambia export demand function



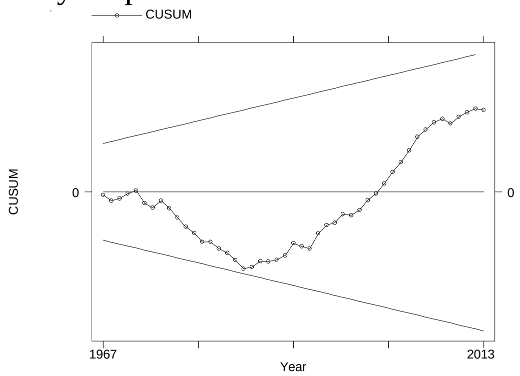


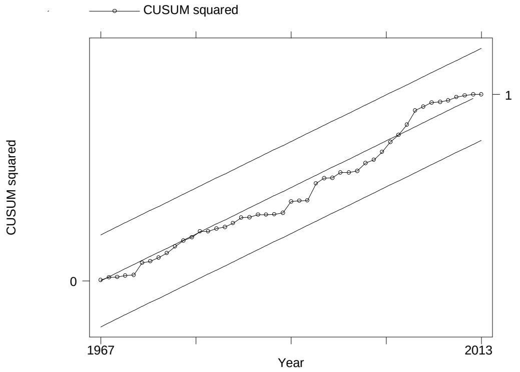
Gambia import demand function



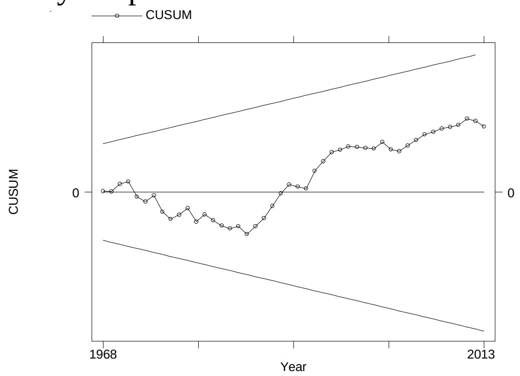


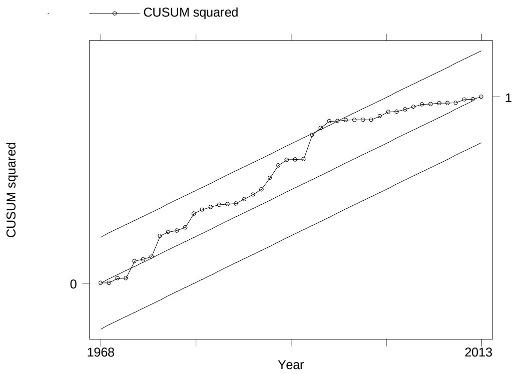
Kenya export demand function



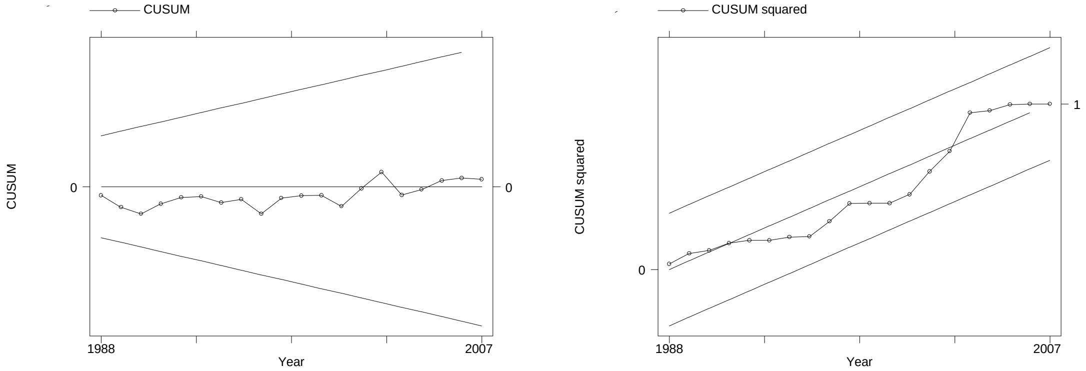


Kenya import demand function

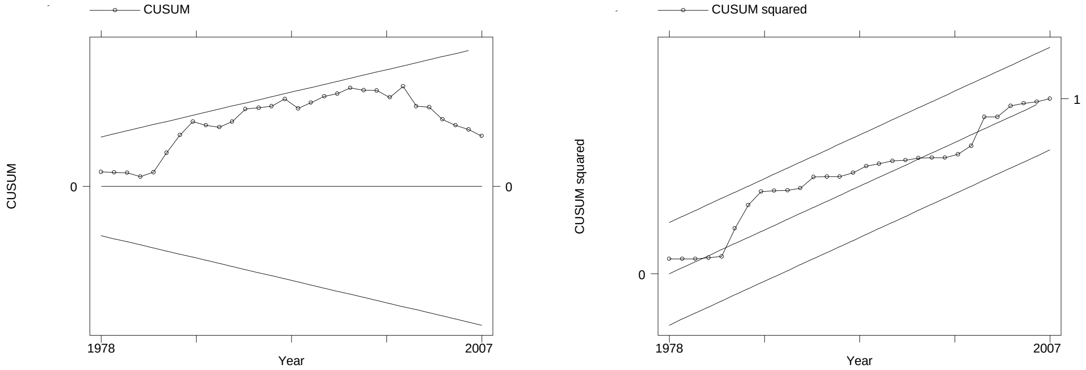




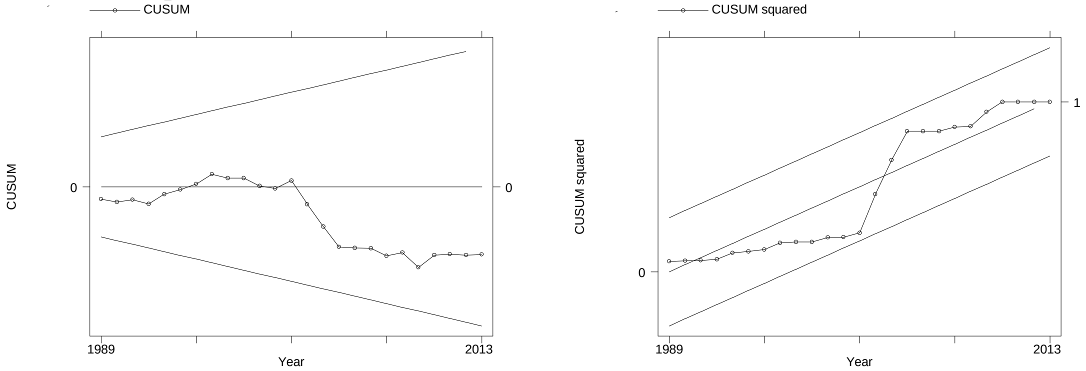
Mali export demand function



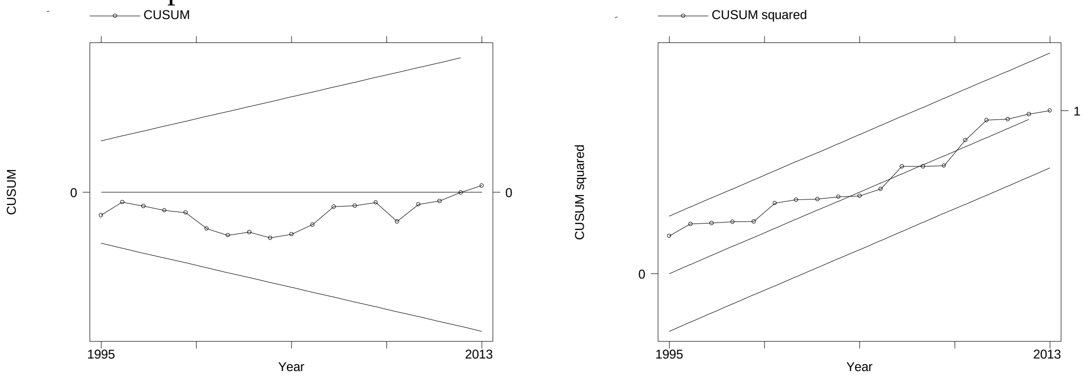
Mali import demand function



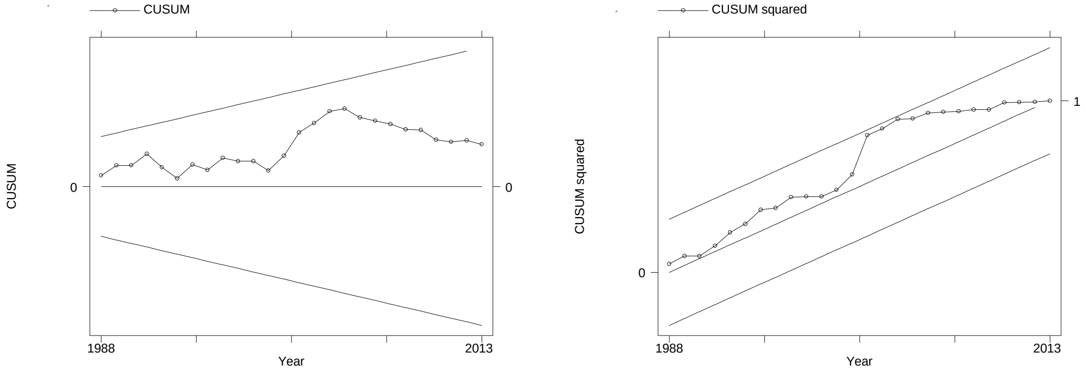
Mauritius export demand function



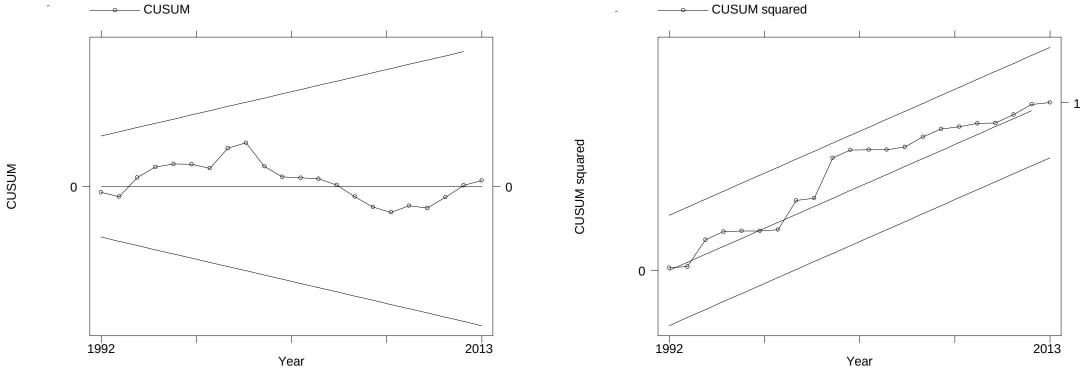
Mauritius import demand function



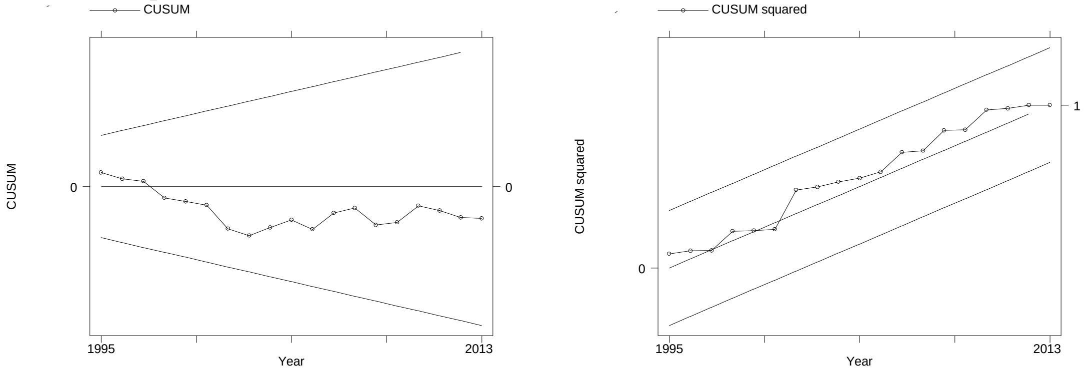
Mozambique export demand function



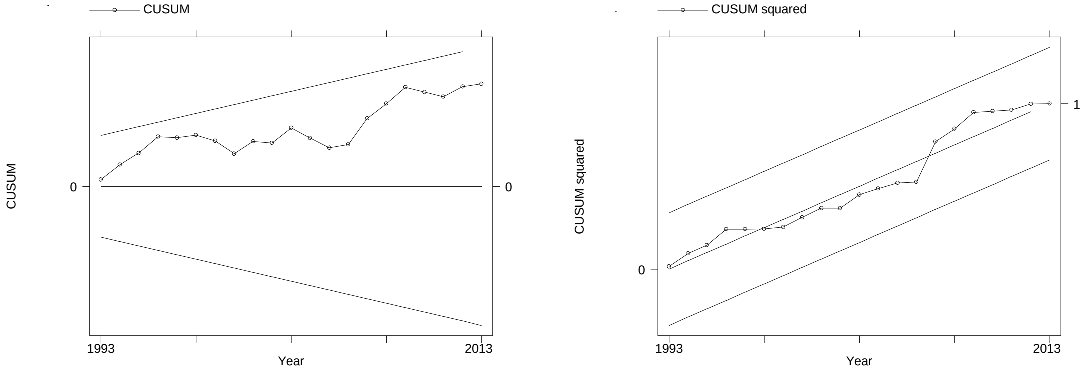
Mozambique import demand function



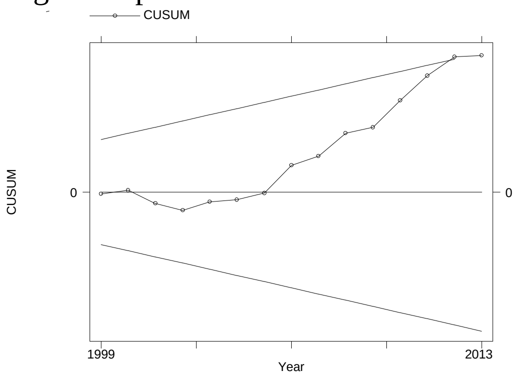
Namibia export demand function

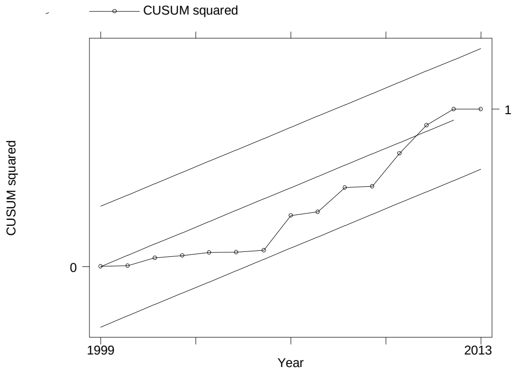


Namibia import demand function

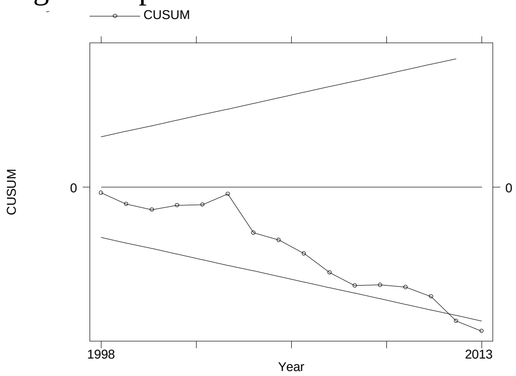


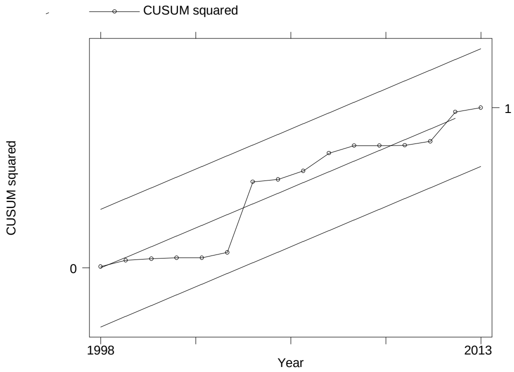
Nigeria export demand function



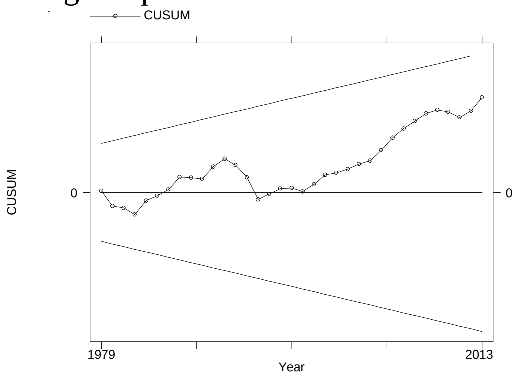


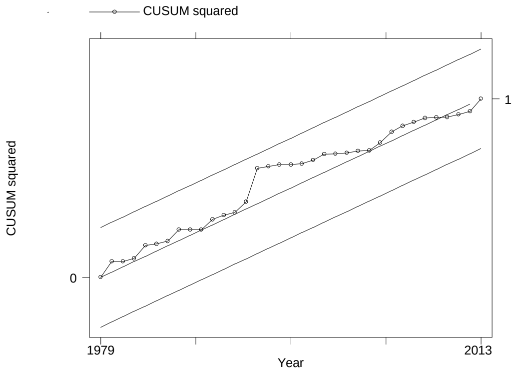
Nigeria import demand function



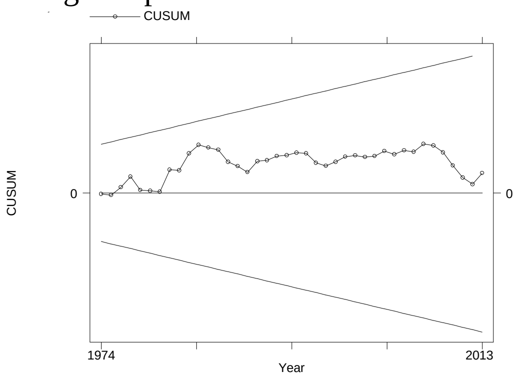


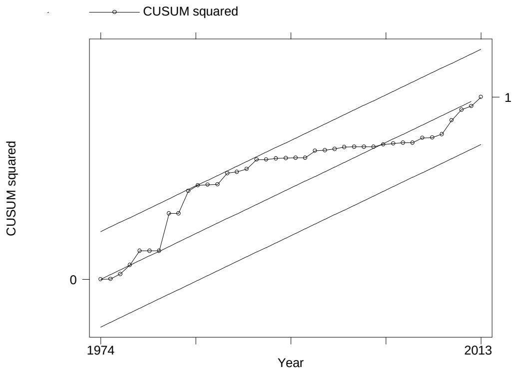
Senegal export demand function



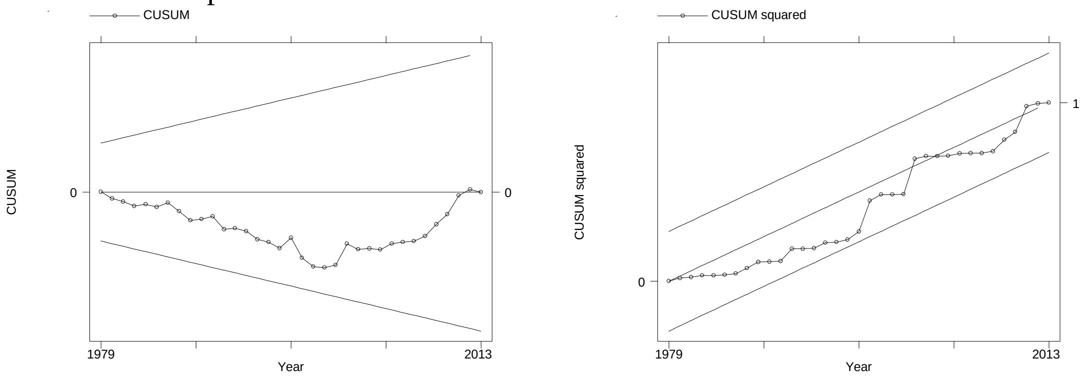


Senegal import demand function

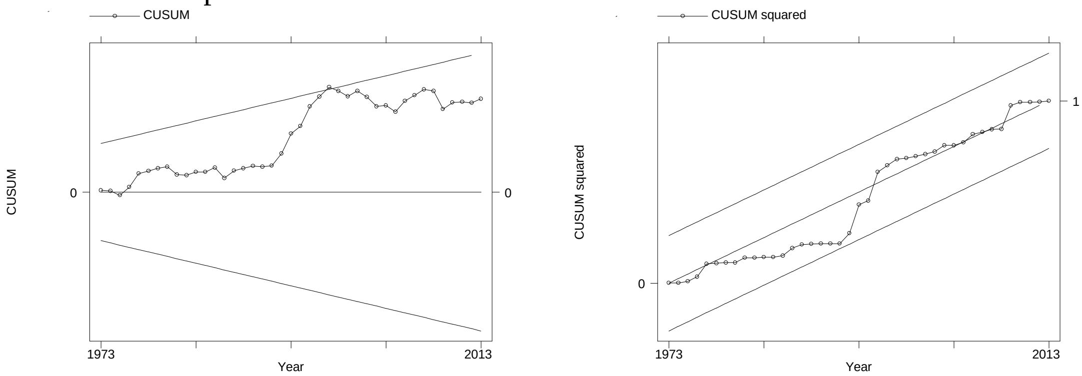




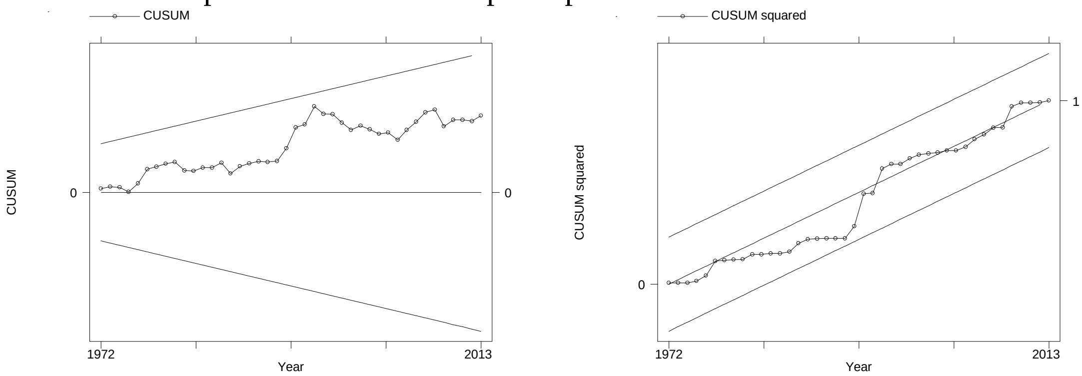
Sierra Leone import demand function



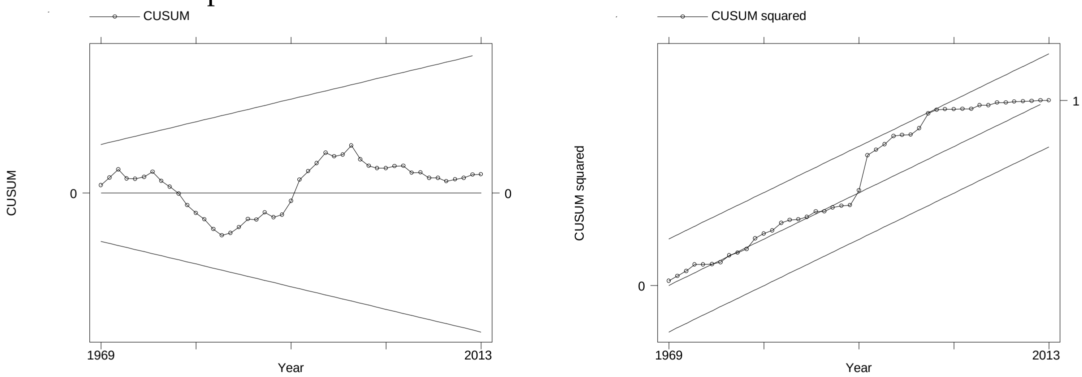
South Africa export demand function



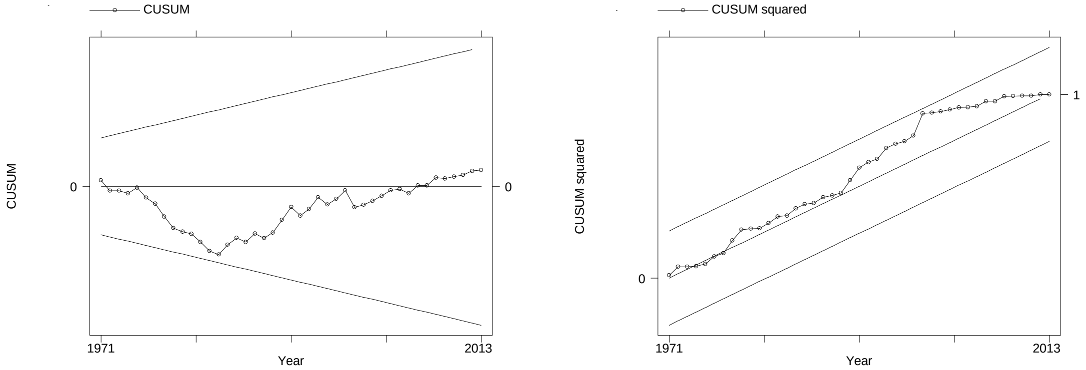
South Africa export demand function post-apartheid



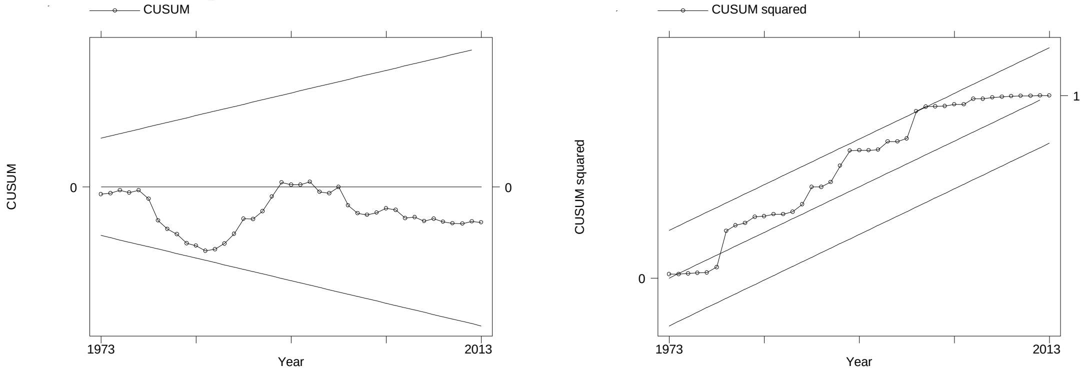
South Africa import demand function



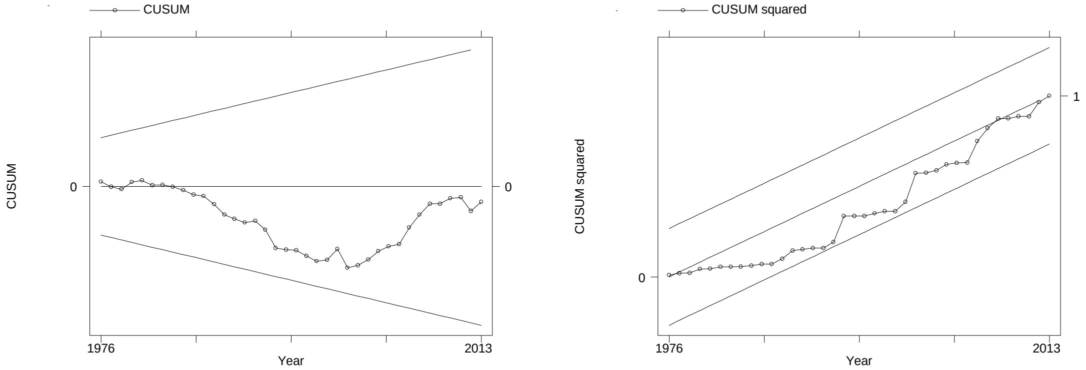
South Africa import demand function post-apartheid



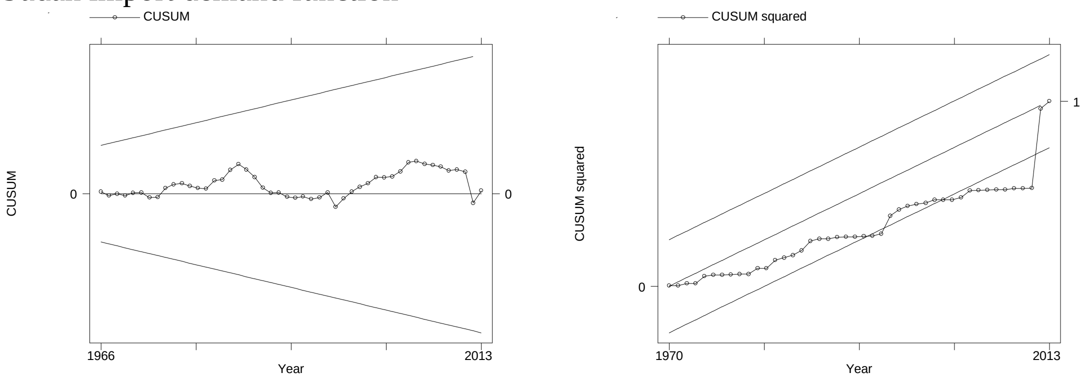
South Africa import demand function with a trend



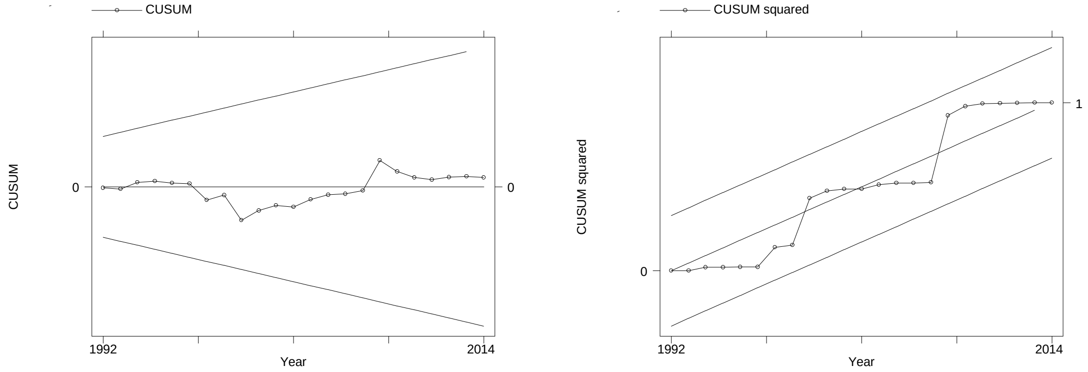
Sudan export demand function



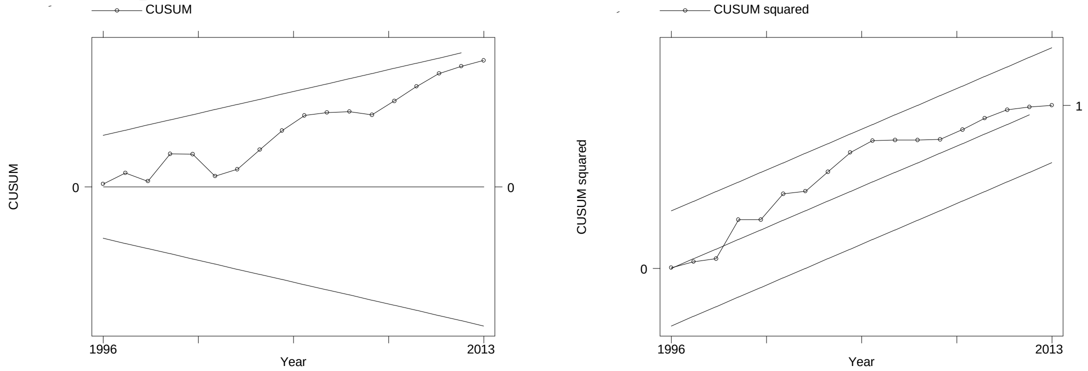
Sudan import demand function



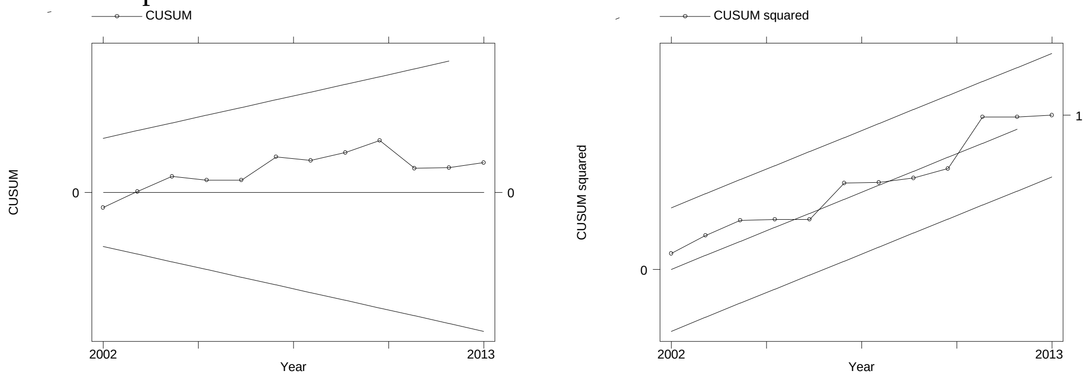
Uganda export demand function



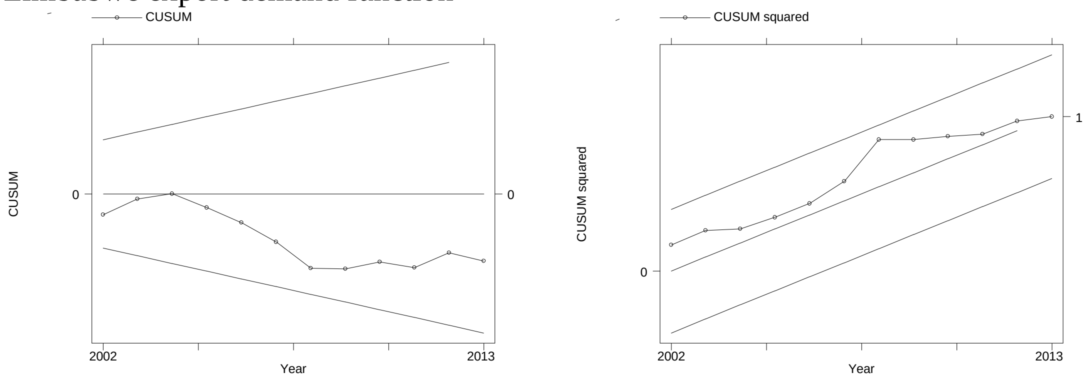
Zambia export demand function



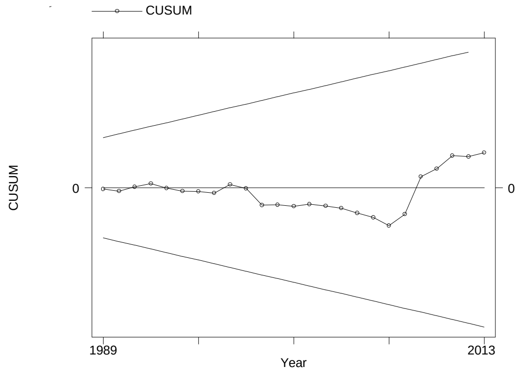
Zambia import demand function

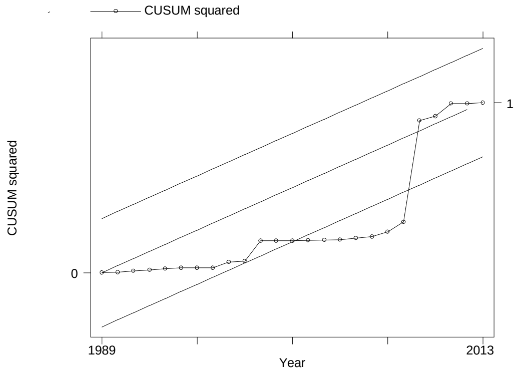


Zimbabwe export demand function



Zimbabwe import demand function





Appendix Q

Stability graphs from the selected panel VAR models for the balance of payments constrained growth, x, or y_{BSDAR}, and the actual rate of growth,y.

Table 5.10, Panel VAR for x and y

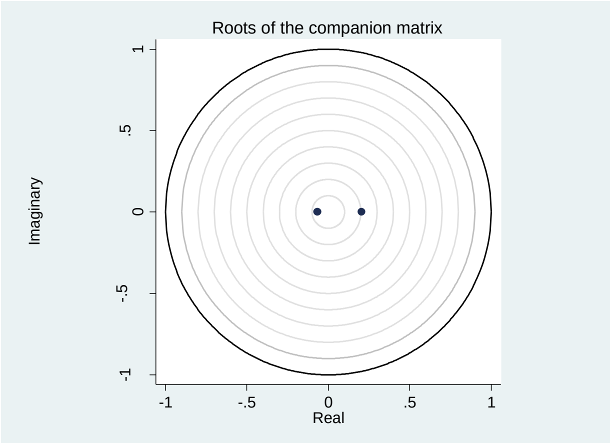


Table 5.10, Panel VAR for x, y and a trend

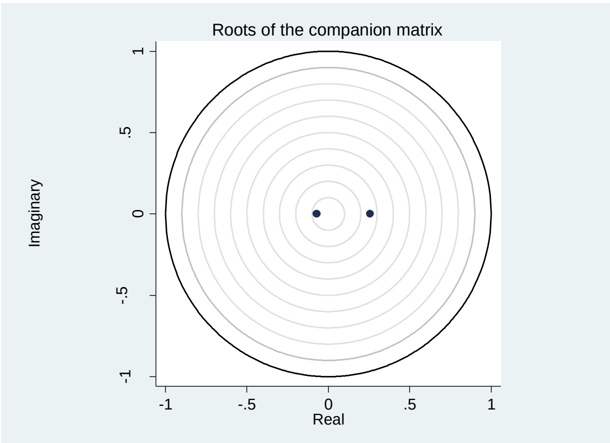


Table 5.10, Panel VAR for x and y, 5 year average

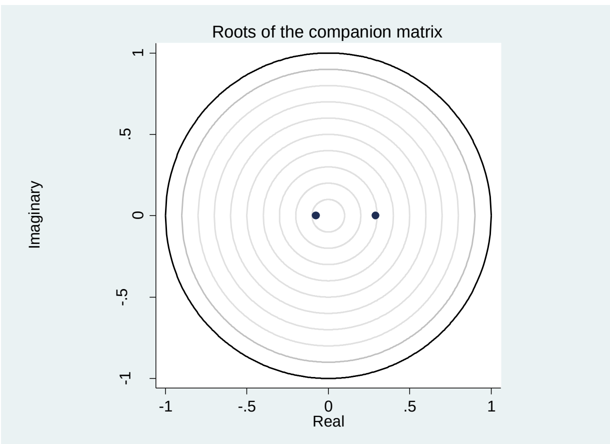


Table 5.10, Panel VAR for x, y and a trend, 5 year average

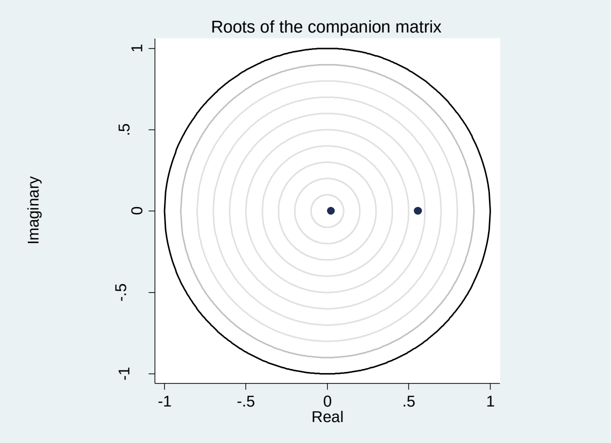


Table 5.11, Panel VAR for, y_{BSDAR} and, y

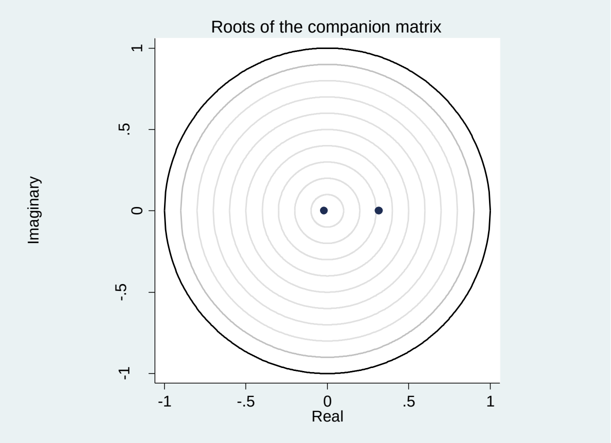


Table 5.11, Panel VAR for, y_{BSDAR}, y and a trend

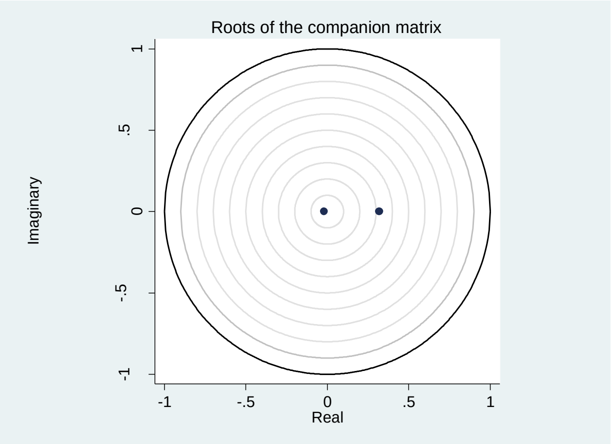


Table 5.11, Panel VAR for, y_{BSDAR} and, y, 5 year average

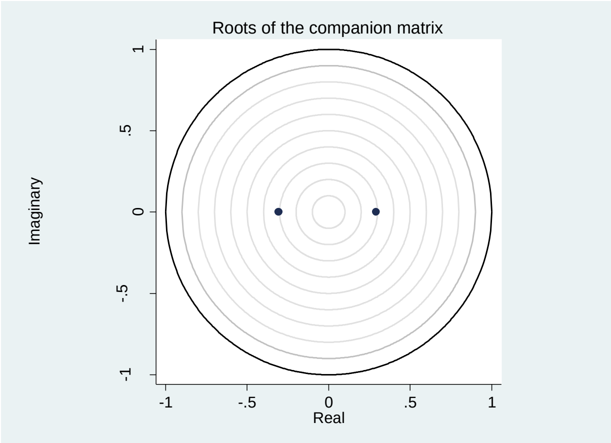


Table 5.11, Panel VAR for, y_{BSDAR}, y and a trend, 5 year average

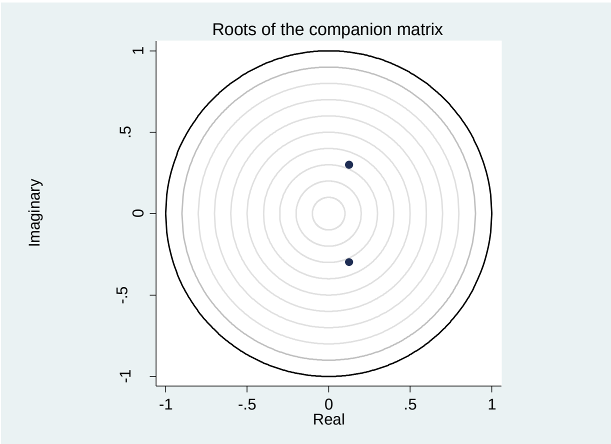


Table in Appendix N, Panel VAR for y_{BSDAR}, lfe and a trend, 5 year average

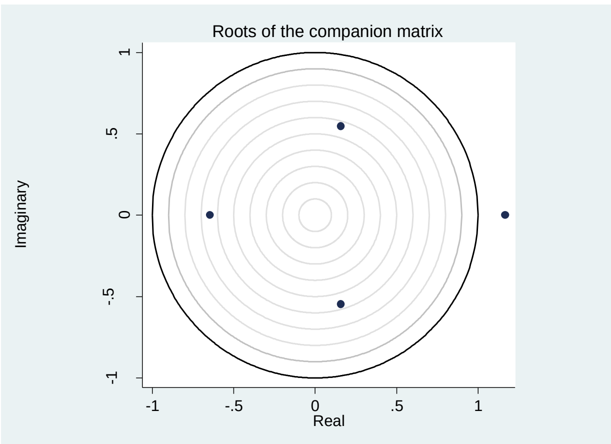
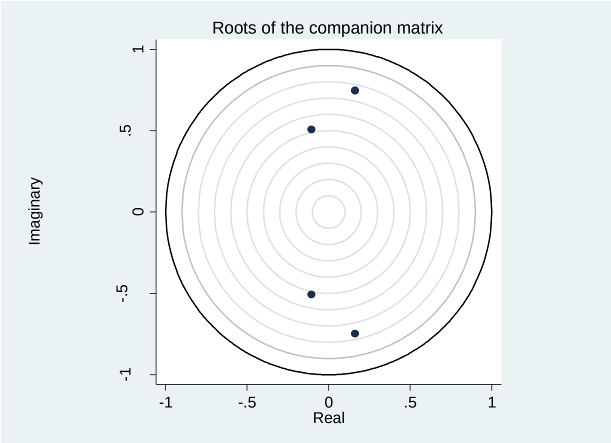


Table in Appendix N, Panel VAR for y_{BSDAR}, lfe and U (control), 5 year average



Appendix R

Stability graphs from the selected panel VAR models for the balance of payments constrained growth, y_{BSDAR}, or x, and the natural rate of growth, lfe.

Table 6.1, Panel VAR for x and lfe

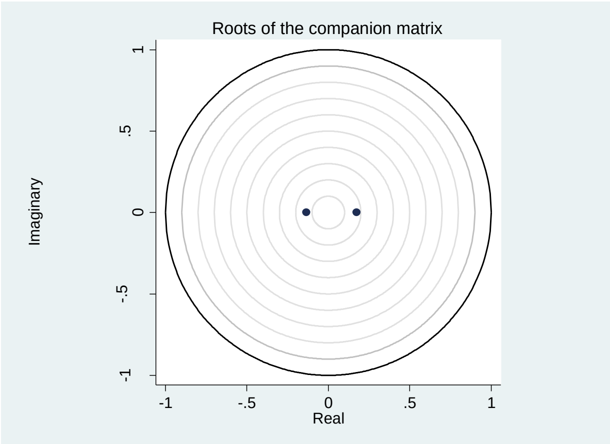


Table 6.1, Panel VAR for x, lfe and a trend

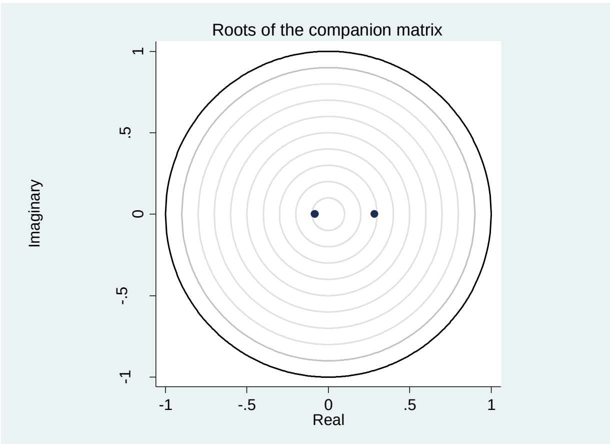


Table 6.1, Panel VAR for x, lfe and U (control)

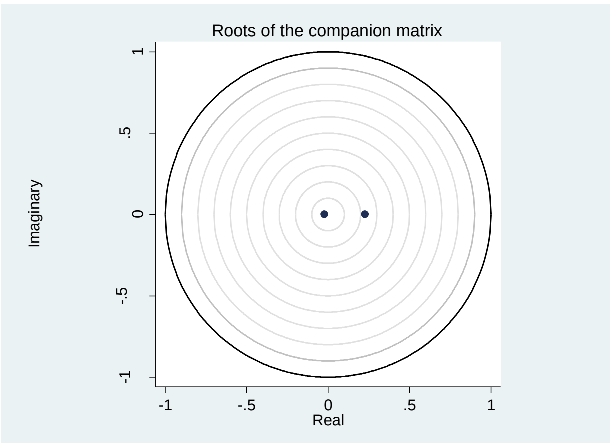


Table 6.1, Panel VAR for x, lfe, U (control) and a trend

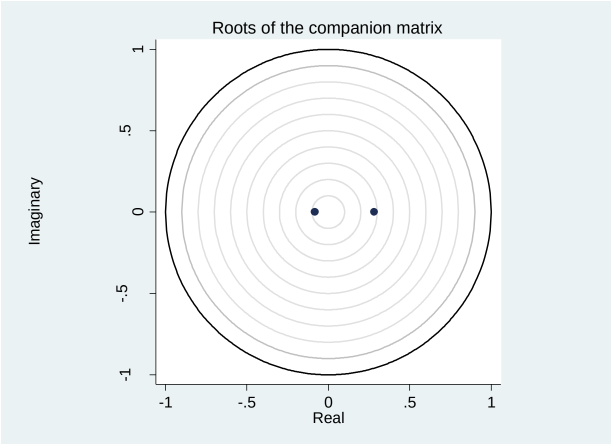


Table 6.1, Panel VAR for x and lfe, 4 year average

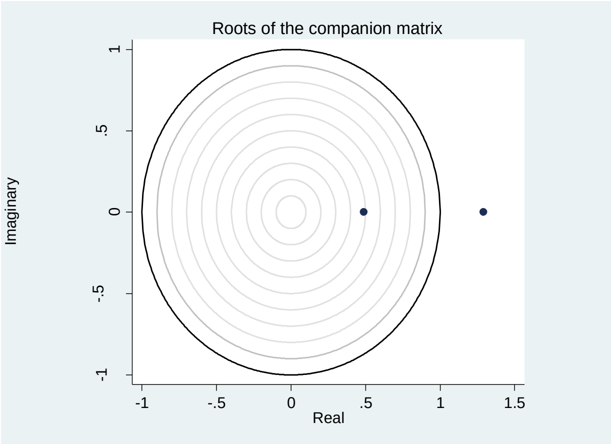


Table 6.1, Panel VAR for x, lfe and a trend, 4 year average

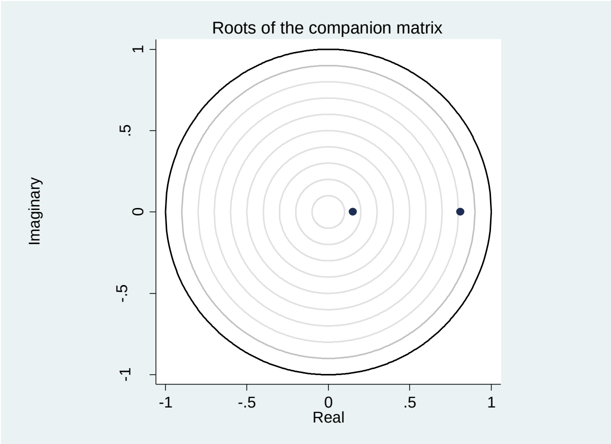


Table 6.1, Panel VAR for x, lfe and U (control), 4 year average

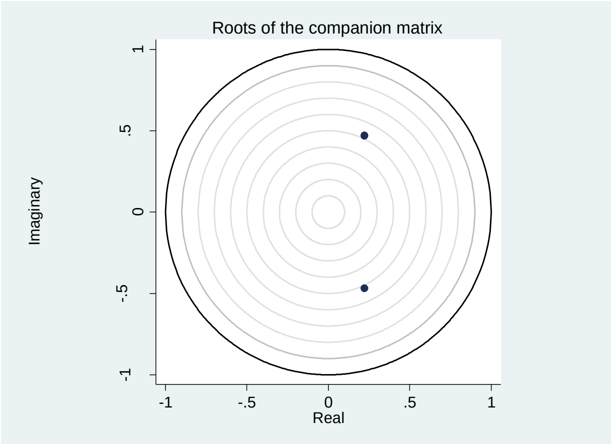


Table 6.1, Panel VAR for x, lfe, U (control) and a trend, 4 year average

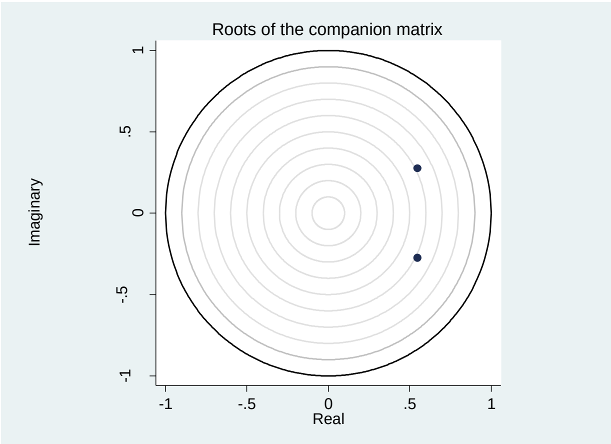


Table 6.2, Panel VAR for y_{BSDAR} and lfe

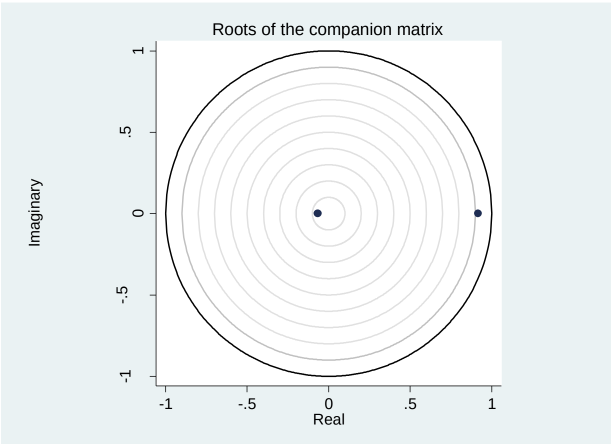


Table 6.2, Panel VAR for y_{BSDAR}, lfe and a trend

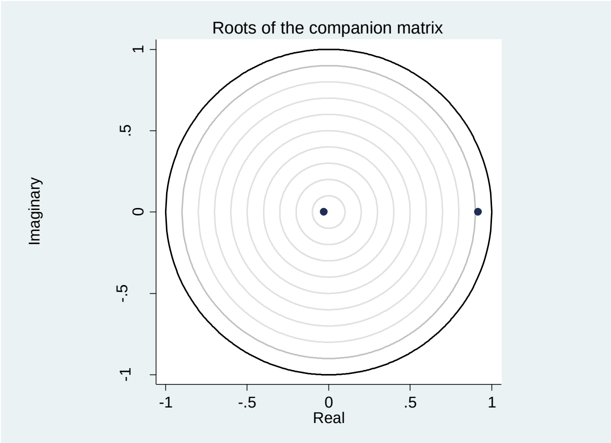


Table 6.2, Panel VAR for y_{BSDAR}, lfe and U (control)

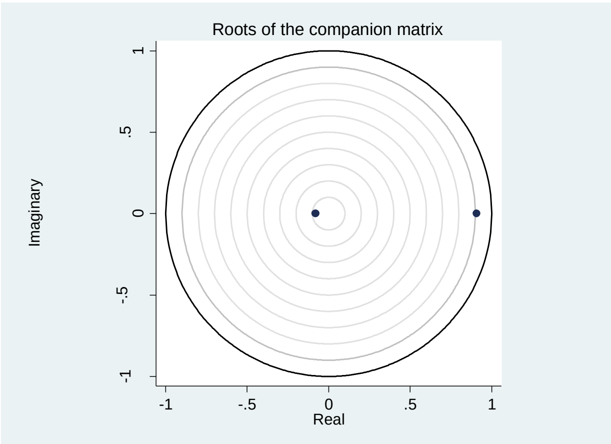


Table 6.2, Panel VAR for y_{BSDAR}, lfe, U (control) and a trend

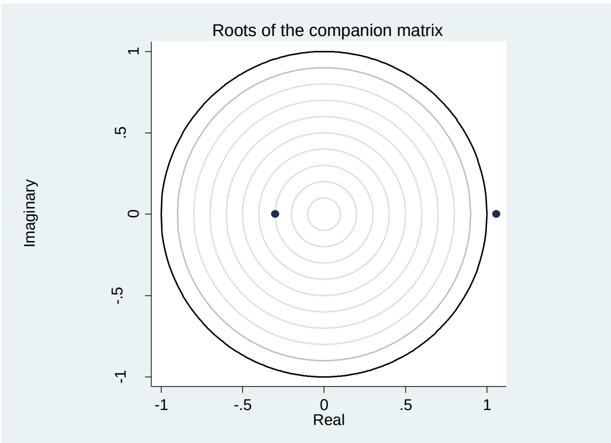


Table 6.2, Panel VAR for y_{BSDAR} and lfe, 4 year average

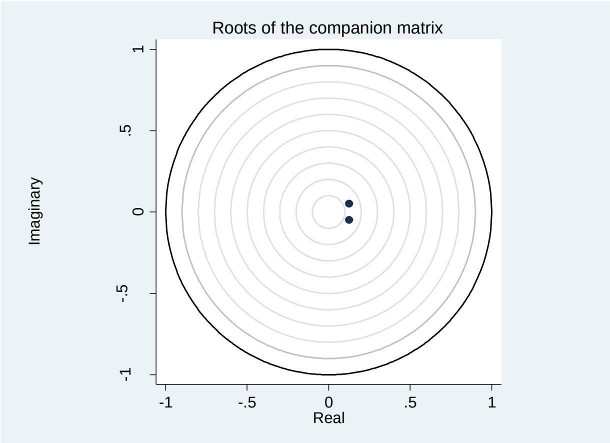


Table 6.2, Panel VAR for y_{BSDAR}, lfe and a trend, 4 year average

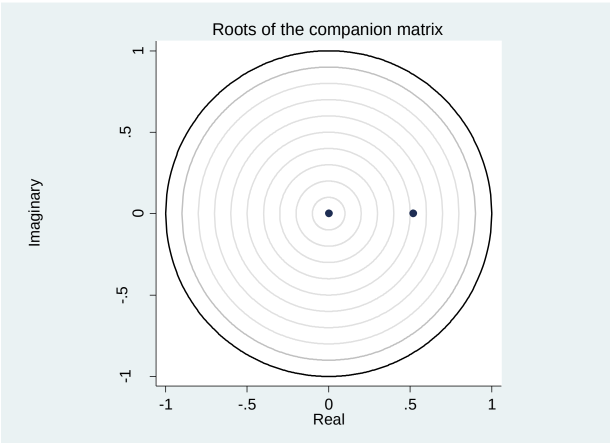


Table 6.2, Panel VAR for y_{BSDAR}, lfe and U (control), 4 year average

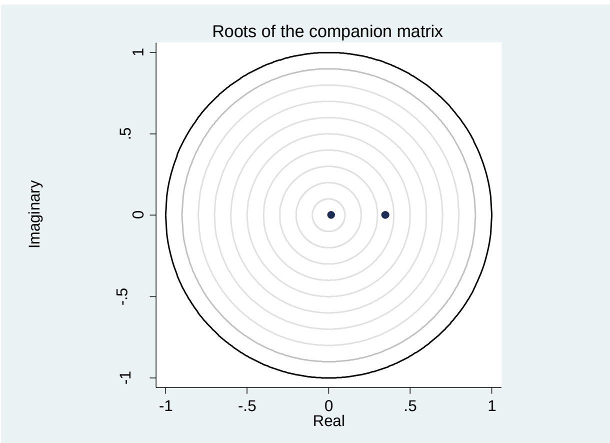
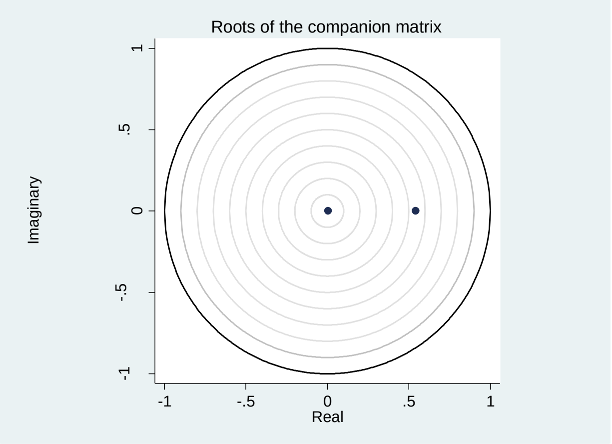


Table 6.2, Panel VAR for y_{BSDAR}, lfe, U (control) and a trend, 4 year average



Appendix S

Stability graphs from the selected panel VAR models for growth in productivity and income, y for the 1991 to 2014 period.

Table 4.11, Panel VAR for productivity and growth, y

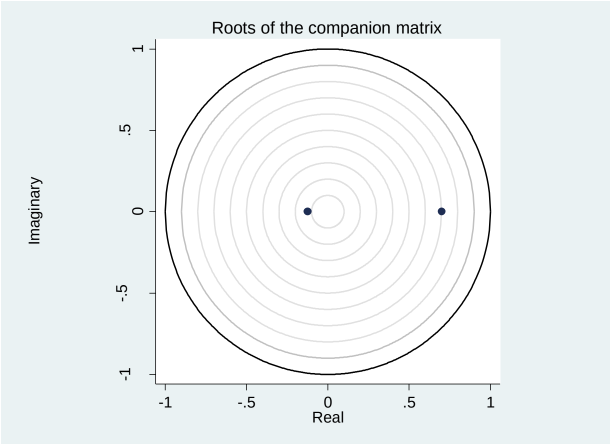


Table 4.11, Panel VAR for productivity, growth, y, and a trend