Economic growth and formal sector employment

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Abstract: Between 2008Q4 and 2016Q4 the number of employed workers in SA increased by 1.3 million. In contrast, the officially unemployed increased by 1.7 million, while discouraged work-seekers increased by 1.1 million. Thus, the broadly unemployed increased by 2.8 million, twice as many as the increase in employed workers. Higher levels of economic activity, i.e. economic growth, usually serve as the main driver behind the growth of employment. Whereas the SA economy was growing in excess of 5% in the mid-2000s, by 2016 it failed to reach even 0.5%. With the unemployment rate increasing from 21.5% in 2008 to 27% in 2016, the economy was clearly failing to generate enough jobs. The objective of this paper is to establish the relationship between economic growth and formal sector employment growth (not enough time-series data exist to include the informal sector). Using a Markov-switching method to distinguish economic up- and downswings the paper finds that there is indeed a business cycle-related relationship between economic growth and formal sector employment growth, but that the influence of economic growth on employment growth is relatively small.

E24, E32, E37

In 2008 South Africa registered an unemployment rate of 21.5%. Then followed the global financial crisis and a recession. From 2008Q4 to 2009Q4 796 000 people lost their jobs. The unemployed according to the official definition increased by 381 000, while discouraged work-seekers increased by 538 000 – thus, the broadly unemployed increased by 918 thousand in a 12-month period. After the worst of the global financial crisis and its associated recession passed employment started to grow again, but the pace at which it has grown has been frustratingly slow. Between 2008Q4 and 2016Q4 the number of employed workers in SA increased by 1.3 million. In contrast, the officially unemployed increased by 1.7 million, while discouraged work-seekers increased by 1.1 million. Thus, the number of people who are unemployed according to the broad definition of unemployment increased by 2.8 million, twice as many as the increase in employed workers. By the end of 2016 the official unemployment rate reached 27%. Only slightly more than four out of every ten working-age individuals in the country had a job.

Usually higher and growing levels of economic activity generate higher and growing levels of employment. Thus, if the economy fails to generate enough jobs, the main reason might be found in low economic growth. This seems to have been the case since 2008. The lackadaisical growth in employment coincided with a slowdown in

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economic growth. Whereas the SA economy was growing in excess of 5% in the mid-2000s, by 2016 it failed to reach even 0.5%. The economy was seemingly clearly failing to generate enough jobs. But low rates of job creation might also be attributable to a low employment intensity, which is the rate at which jobs are created for every percentage point of economic growth. Thus, one of the questions explored in this article is whether or not employment growth has been lacking because of a low employment intensity, or low economic growth. A low employment intensity is associated with jobless growth, a phenomenon this articles explores.

Thus, the objective of this article is to establish:

a) Whether or not higher economic growth leads to higher employment growth?
b) And if so, with how much does employment grow for each percentage point of economic growth?
c) If economic growth does lead to higher levels of employment, does its impact differ depending on whether the economy is in a boom or recession?

Typically economic literature approaches the relationship between GDP output and employment from either an employment or an unemployment angle. The unemployment angle is encapsulated by what economists call Okun's Law. Okun's Law comes in two formats. The first considers the relationship between unemployment and economic growth: Higher (lower) economic growth is said to lead to lower (higher) unemployment. The second version focuses on the relationship between unemployment and the output gap: As the economy moves beyond (falls short of) potential output, unemployment falls (increases). Focusing on unemployment in the South African case is problematic, as a reliable unemployment data series with a sufficiently high frequency does not extend that far back in time. Only since 2008 does StatisticsSA release a Quarterly Labour Force Survey. And up to the late 1990s unemployment data was only available with an annual frequency. However, a quarterly employment data growth series is available from the South African Reserve Bank (SARB), which it compiled from data collected by StatisticsSA in its Quarterly Employment Survey (and its predecessors), and it extends back decades.[2] Thus, this article considers the relationship between economic growth and employment growth, which is the other angle with which to explore the relationship between output and employment. The drawback of using the SARB's employment series is that it only covers the formal sector, and thus not the informal sector. Thus, the scope of this article is limited to exploring the relationship between GDP growth and formal sector employment growth.

Notice too that with its focus on GDP growth, which as a variable stands central to any business cycle analysis, this article has a particular business cycle angle. Specifically, the article employs a Markov-switching method to explore whether or

[2] The SARB database also supplies the quarterly employment series in levels. However, it has a number of breaks. The growth in employment series, though, has been statistically linked to deal with the breaks. Using the growth series one can then also create a new level index.

not there is a business cycle dimension to the relationship between GDP growth and employment growth. The article applies the Markov-switching method within a Vector Error Correction framework to also accommodate the possibility that there are both short- and long-run components to the relationship between output and employment.

The relationship between employment growth and GDP growth

Theoretically output and employment can be linked through a simple production function. Upender (2006:198-9) uses a constant elasticity of substitution (CES) production function to derive the relationship between employment and output:

$$Y_t = A[\delta K_t^{-\rho} + (1-\delta)E_t^{-\rho}]^{-\eta/-\rho} \quad (1)$$

where:
Y: output
K: Capital
E: Employment
ρ: Substitution (between K and E) parameter, with ρ>-1, with $r = 1/(\rho+1)$ being the elasticity of substitution

The partial derivative of labour (which is the marginal product of labour) is:

$$\frac{dY_t}{dE_t} = (\frac{\eta(1-\delta)}{A^{\rho/\eta}})Y_t^{(1+\rho)/\eta}/E_t^{\rho+1} \quad (2)$$

When solved for employment, this yields the following demand function for labour:

$$E_t = [\eta(1-\delta)/A^{\rho/\eta}]^{1/(\rho+1)}Y_t^{(1+\rho/\eta)(1/(\rho+1))}$$

which simplifies to:

$$E_t = \beta_0 Y_t^{\beta_1} \quad (3)$$

where:
$\beta_0 = [\eta(1-\delta)/A^{\rho/\eta}]^{1/(\rho+1)}$
$\beta_1 = (1+\rho/\eta)(1/(\rho+1)) = (1+\rho/\eta)s$
$r = 1/(\rho+1)$

Taking natural logs then yields the following linear function:

$$lnE_t = ln\beta_0 + \beta_1 lnY_t \quad (4)$$

Equation (4) represents the relationship between the levels of employment and GDP that this article explores. The discussion on the relationship between employment and

GDP also encompasses the discussion on whether or not economic growth is jobless growth. However, the definition of jobless growth is not always clear. In quite literal terms jobless growth would mean zero or even negative employment growth in the face of positive economic growth. However, Bhorat and Oosthuizen (2006) provide two further, more nuanced definitions: a) positive economic growth combined with employment growth that is slower than the growth of the labour force, hence resulting in a higher unemployment rate; and b) positive economic growth combined with growth in employment below what is considered a satisfactory level. What constitutes a satisfactory level is open to policy definition. For instance, should economic policy aim to reduce the unemployment rate over a number of years, what constitutes a satisfactory level is that level of employment growth that will ensure that the unemployment rate decreases as envisaged by the policy. Thus, in terms of the two additional definitions jobless growth does not strictly entail zero job growth, merely job growth that is too slow compared to another standard such as labour force growth. If jobless growth is positive economic growth combined with growth in employment that is slower than the growth in the labour force, then any increase in the unemployment rate while economic growth is positive, qualifies as a period of jobless growth. Using this definition and considering the data noted above, South Africa experienced jobless growth from the rebound from the global financial crisis in 2008 to 2016. In 2017 the economic growth rate turned negative.

Islam (2010:3-4) refines the definition of jobless growth further by presenting four combinations of employment growth and GDP growth. In these four combinations what constitutes 'high' or 'low' depends on whether or not employment grows faster than the labour force. Islam (2010:3-4) is unfortunately not clear on what constitutes 'high' and 'low' GDP growth.

1) High GDP growth and high employment growth;
2) High GDP growth and low employment growth (jobless growth)
3) Low GDP growth and low employment growth
4) Low GDP growth and high employment growth

Using this definition South Africa might not have experienced jobless growth in the period 2008-2016 because it might have fallen in category (3) and not in category (2) of Islam's classification. Although these distinctions as to what constitutes jobless growth might sound like the mere semantic splitting of hair, the point that Islam (2010) wants to drive home remains relevant. Islam's (2010) point can be simply stated in terms of β_1 in Equation (4) above. Thus, if we define low employment growth as employment growth that leads to an increase in the unemployment rate, then employment growth can be low either because the employment intensity, β_1, or the economic growth rate, ΔY, is low (of course they might be both low simultaneously). What constitutes a 'low' β_1 or ΔY depends on the degree of freedom available taking either β_1 or ΔY as a given. Thus, if β_1 is given, then ΔY will be low if it causes unemployment to increase, while if ΔY is taken as given, then β_1 will be too low if it results in an increase in unemployment. If unemployment is increasing, one could also compare β_1 or ΔY to their values in other countries to establish whether or not they are too low.

Various estimates exist of the size of β_1 for a number of countries. A summary of the papers reporting estimates of β_1 can be found in Sassi and Goaied (2016:255-6). Some of the relationships were stated in the levels between output and employment, while other between the growth rate of output and the growth rate of employment. Sassi and Goaied (2016:255-6) note values ranging from 0.31 to 0.61 in various US states for the period 1990-2003, 0.47 to 0.66 at different times in Indonesia, 0.5 to 0.6 in OECD countries in the period 1960-93. In addition, Sassi and Goaied (2016:255-6) also report on a study finding a range of 0.3 to 0.38 in a panel of a 160 countries for the period 1991-2003, while another study covering the period 1991-2009 found a value for β_1 of 0.99 in South Asia, 0.81 in the US, 0.64 in Western Europe, 0.23 in Eastern Europe, 0.1 in North Africa/Middle East and an almost zero value of -0.02 in Sub-Saharan Africa. Estimates of the size of β_1 therefore range the whole spectrum, from low values to very high values.

Modelling the relationship between unemployment and growth

To estimate the relationship between employment and output requires dealing with a number of aspects that preclude merely regressing employment growth on GDP growth or the log-level of employment on the log-level of output (as Equation (4) seems to suggest). These include business-cycle-related non-linearities, differences in short- and long-run behaviour, as well as issues regarding non-normality caused by shocks to growth in employment and output.

Business-cycle-related non-linearities: Markov-switching modelling

Whenever discussing the role of GDP growth in employment growth it also entails considering the role of the business cycle and whether or not the impact of GDP growth on employment growth depends on the cycle. Given that in some countries the business cycle has been found to play a role in the relationship between output growth and unemployment, i.e. in Okun's Law (Valadhani 2014), it would not be surprising that it also plays a role in the relationship between output growth and employment growth. Various authors use different methods to account for the possible non-linear relationship between output growth and either unemployment or employment growth. These include the use of a Markov-switching framework (Valadhani and Smyth 2015; Valadhani 2014; Holmes and Silverstone 2006), non-linear smooth transition models (Chinn, Ferrara and Mignon 2014), time-varying transition probabilities (Holmes and Silverstone 2006) and the use of current depth regressions (McFarlane, Das and Chawdhury 2104). To allow for such non-linear behaviour and to distinguish economic upswings from economic downswings when estimating the relationship between economic growth and employment growth this article draws on the Markov-switching approach of Hamilton (1989; 1996; 2008). Based on the work by Hamilton (1989; 1996; 2008), economists have used Markov-switching (MS) models to investigate the behaviour of a number of economic variables. Most popular has been investigating the behaviour of economic growth, with the regimes distinguishing economic upswing phases from economic downswing phases. Other applications of Markov-switching models include investigating the behaviour of inflation, employment and unemployment. For instance, see Simon (1996), Beccarini and Gros (2008) and Pagliaci and Barráes (2010) who use MS models to estimate inflation dynamics, while Holmes and Silverstone (2006), Valadkhani and Smyth (2015) and Valadkhani (2015) estimate Okun's Law using MS models.

To verify that the regimes identified in the relationship between employment growth and GDP growth are indeed business-cycle related regimes the article first presents univariate Hamilton-type Markov-switching AR(1) models for GDP growth. The regimes identified in these AR(1) models are then compared to the business cycles as identified by the South African Reserve Bank (SARB). The SARB identifies recessions using the traditional practice first set by Burns and Mitchell in the 1940s in the US, which entails a detailed study of multiple time-series and indices, upon which the SARB then makes a judgement as to when a cyclical turning point occurred. Using for comparison the recessions identified by the Markov-switching GDP growth AR(1) model and the SARB's method, a Markov-switching vector-error correction model is built for the employment-output relationship.

A Markov-switching model assumes the presence of two or more regimes. These regimes are unobservable at time *t*. However the regimes are determined by an unobservable process, s_t. Lets assume the presence of two regimes. Also assume the presence of an AR(1) process. The Markov-switching model is then:

$$y_t = \phi_{0,s_t} + \phi_{1,s_t} y_{t-1} + \phi_{k,s_{t-i}} x_{k,t-i} + \varepsilon_t \quad (5)$$

Where:
y_t: an endogenous variable
$x_{k,t-i}$: and exogenous variable k at lag $t-i$
$s_t = 0, 1$, which denote Regime 0 and Regime 1
ϕ_{0,s_t}: a constant term, assumed to be different in Regimes 0 and 1
ϕ_{1,s_t}: coefficient of the AR(1) term, assumed to be different in Regimes 0 and 1
$\phi_{k,s_{t-1}}$: coefficient of exogenous variable k at lag $t-i$, assumed to be different in Regimes 0 and 1
ε_t: the error term, assumed to be IID with a mean of zero mean and a constant variance σ. The analysis could also allow for the variance of the residual term to differ between Regimes 1 and 2.

Furthermore, a Markov-switching model assumes that process s_t is a first-order Markov-process (Hamilton, 1989). Thus, the current regime s_t depends on s_{t-1}, which implies the following transition probabilities:

$$P(s_t = 0|s_{t-1} = 0) = p_{00}$$
$$P(s_t = 1|s_{t-1} = 0) = p_{01}$$
$$P(s_t = 0|s_{t-1} = 1) = p_{10}$$
$$P(s_t = 1|s_{t-1} = 1) = p_{11} \qquad (6)$$

Where:
p_{00}, p_{01}, p_{10} and p_{11} are non-negative
$p_{00} + p_{01} = 1$
$p_{10} + p_{11} = 1$

The unconditional probabilities that the process is either in Regime 0 or Regime 1 are shown in Equations (7) and (8), and can be derived with ergodic Markov chain theory (see Franses and van Dijk (2000)):

$$P(s_t = 0) = \frac{1-p_{11}}{2-p_{00}-p_{11}} \qquad (7)$$

$$P(s_t = 1) = \frac{1-p_{00}}{2-p_{00}-p_{11}} \qquad (8)$$

The parameters of the Markov-switching models, including the variable parameters, transition probabilities, and probabilities with which each state occurs, are estimated using the maximum likelihood method.

The VECM approach followed

Following Sassi and Goaied (2016), Škare and Caporale (2014), Caporale and Škare (2014), and Şahina, Tanselb and Berument (2014) the employment-output relationship is specified as an Error-Correction Model to distinguish the short- and long-run behaviour of the relationship between employment and output. Sassi and Goaied (2016), Škare and Caporale (2014), and Caporale and Škare (2014) did so in a panel setup to estimate the relationship in a large number of countries, while Şahina, Tanselb and Berument (2014) estimated a time-series model for Turkey. This article focuses only on South Africa and hence, uses a time-series approach to its Error-Correction modelling. An Error-Correction Model has the benefit of not losing the long-run information that would occur if the analysis were limited to merely estimating the relationship between the growth rates of employment and output. Focussing on one country also allows for the combination of the Error-Correction Modelling with the Markov-switching approach. Hence, this article uses a MS-VECM approach that allows for a distinction between long- and short-run behaviour and, in the short-run component of the model allows for business cycle-related behaviour modelled using a Markov-switching approach.

Instead of estimating a single-equation model of the percentage change in employment, with an error-correction component, the model in this article is estimated using a two-step approach. Akin to the Engle-Granger method the first step entails estimating the long-run relationship between the log-levels of employment and output. The residual of this estimation is then used in the second step. Unlike the Engle-Granger method that simply estimates a single equation normalised on, say, the percentage change in employment, the second step in this article entails the estimation of a Markov-switching VAR that includes the lag of the residual estimated in the first step as error-correction terms. The use of the VAR setup deals with questions of endogeneity between employment growth and output growth.

Dealing with normality

However, none of the above estimation can be done without first dealing with the problem of non-normality in the data. Both the employment and GDP series display a number of spikes (shocks) and not controlling for these spikes result in all the models failing their normality tests.

For both GDP growth and employment growth the article identifies these spikes using Impulse Indicator Saturation (IIS) dummies in AR(1) models that are estimated with Hendry's General-to-Specific (GETS) procedure. This method identifies spikes and creates a dummy for each spike. Thus, using GETS with IIS dummies means that spikes are identified in a systematic, non-*ad hoc* manner. These dummies are subsequently included in the second step of the MS-VEC model that explores the relationship between economic growth and employment growth.

The GETS procedure in this case entails including a lag of the dependent variables as well as a dummy for each and every period, called the IIS dummies. This model is called a General Unrestricted Model (GUM). Because this model, with all the IIS dummies, will have more variables than observations, its degree-of-freedom problem means that not all the dummies can be included in one round of estimation. Thus, the GETS procedure will divide all the variables (i.e. the AR(1) term and all the dummies) into blocks. The dependent variable is then regressed on each block to identify statistically significant variables. Once that is done, those variables identified as not statistically significant are again divided into blocks and the dependent variable is regressed on the variables identified as statistically significant in the previous round, as well as on each of the blocks of insignificant variables in turn. In this second round some variables that came out as statistically insignificant in the previous round might come out as statistically significant, while others that came out at statistically significant might come out as statistically insignificant. Further rounds then repeat the procedure of the second round until adding further rounds does not improve the model. A set of diagnostic tests determines when the model cannot be improved by adding another round. Should the procedure identify more than one model, the GETS procedure applies encompassing tests to select the final model. The

IIS dummies that survive this process identify the spikes and controlling for these spikes ensures that the model passes the normality tests.[3] (See Ericsson (2010) and Doornik (2009) for more detail on GETS).

The model estimated

The model estimated is a MS-VEC model. Its long-run component is:

$$lnE = \beta_0 + \beta_1 lnY_t + \varepsilon_{LR,t} \qquad (6)$$

while the short-run component is:

$$\Delta E_t = c_{10,s_t} + \alpha_{11,s_t}\varepsilon_{LR,t-1} + c_{11,s_t}\Delta Y_{t-1} + c_{12,s_t}\Delta E_{t-1} + \sum d_{1i}D_i + \varepsilon_{SR1,t}$$
$$\Delta Y_t = c_{20,s_t} + \alpha_{21,s_t}\varepsilon_{LR,t-1} + c_{21,s_t}\Delta Y_{t-1} + c_{22,s_t}\Delta E_{t-1} + \sum d_{2i}D_i + \varepsilon_{SR2,t}$$
$$(7)$$

where:
β_1 and β_2: the long-run parameters relating the log-levels of employment and GDP;
α_{11} and α_{21}: the error-correction parameters, with $-1<\alpha_{11}<0$ and $\alpha_{21}\geq 0$;
s_t: denotes either Regime 0 or Regime 1 in the Markov-switching modelling; and
D_i: the IIS dummies included to deal with shocks to the employment growth and GDP growth series in quarter *i*.

Data

The data is the SARB's quarterly employment index and real GDP series for the period 1982(1)-2016(2), thus a sample period of almost 35 years, or 138 observations. The SARB's quarterly employment index series excludes the informal and agricultural sectors. However, it is the most comprehensive employment series available for an extended period of time – hence, its use in this article. The results should therefore be interpreted as establishing the relationship between GDP growth and growth in formal sector employment. The sample commences in the early 1980s because the South African Reserve Bank liberalised financial markets at that time by abolishing fixed interest rates and credit ceilings, while the government liberalised the labour market by allowing black workers for the first time to belong to labour unions.

Table 1 – KPSS test of stationary

	Level	1st Diff	Conclusion
LEmpl	1.214	0.179	I(1)
LGDP	1.440	0.410	I(1)

5% critical value 0.463

The log-level series for employment and real GDP are both I(1) – see Table 1 reporting the results for the KPSS test. The KPSS test is more robust than the ADF

[3] Autometrics in the PcGive plugin of Oxmetrics7 automated the GETS procedure.

and PP tests traditionally employed to explore stationarity. Unlike the ADF and PP test its null hypothesis is that the variable is stationary.

Empirical results

To create a baseline for distinguishing economic upswings from recessions, this section first estimates a Markov-switching AR(1) model for economic growth. The analysis shows that it is necessary to also control for shocks in GDP growth and employment growth, since models not doing so suffer from normality problems. The recessions identified estimating the MS AR(1) model for economic growth are compared to the recessions identified by the SARB to verify that the MS model's regimes indeed do represent recessionary and upswing phases. Subsequent to this the section presents the MS VEC model that relates employment to output.

Economic growth, employment growth and problems with normality

Four economic growth models were run and all four are autoregressive (AR(1)) models:

1) The constant is subject to regime change, the variance and $DGDP_{-1}$ are not;
2) The constant and variance is subject to regime change, $DGFP_{-1}$ is not;
3) The constant and $DGDP_{-1}$ are subject to regime change, the variance is not; and
4) The constant, $DGDP_{-1}$ and the variance are all subject to regime change.

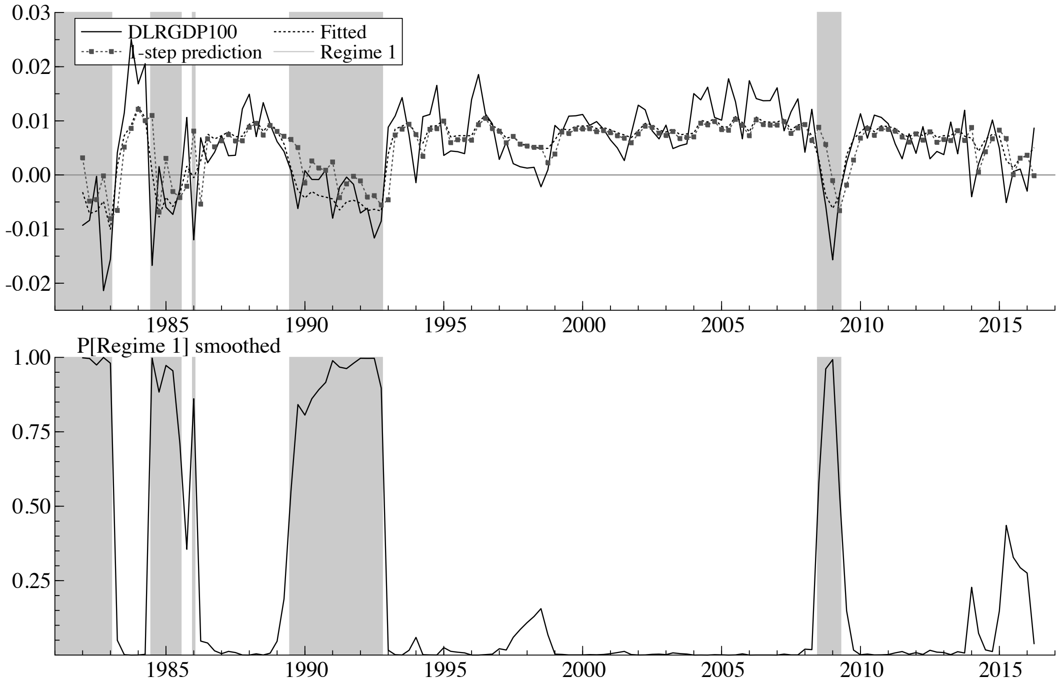
Table 2 – Regime-switching model for economic growth

$DGDP_{-1}$	0.257 (0.002)					
Constant(0)	0.006 (0.000)					
Constant(1)	-0.005 (0.001)					
Other coefficients						
Sigma	0.0054 [0.0004]					
p_{0|0}	0.951 [0.029]					
p_{1|1}	0.801 [0.0994]					
Linearity LR χ^2-test (prob)	0.002					
Normality χ^2-test (prob)	0.008					
ARCH 1-1 F-test (prob)	0.059					
Portmanteau χ^2-test (prob)	0.516					
	Regime 0,t			Regime 1,t		
Regime 0,t+1	0.951			0.199		
Regime 1,t+1	0.049			0.801		
Regime classification based on smoothed probabilities	Regime 0	Quarters	Avg.prob.	Regime 1	Quarters	Avg.prob.
	1983(2) - 1984(2)	5	0.989	1982(1) - 1983(1)	5	0.990
	1985(4) - 1985(4)	1	0.644	1984(3) - 1985(3)	5	0.904
	1986(2) - 1989(2)	13	0.971	1986(1) - 1986(1)	1	0.861
	1993(1) - 2008(2)	62	0.985	1989(3) - 1992(4)	14	0.904
	2009(3) - 2016(2)	28	0.925	2008(3) - 2009(2)	4	0.768
	Total: 109 quarters (78.99%) with average duration of 21.80 quarters			Total: 29 quarters (21.01%) with average duration of 5.80 quarters		

Note: ( ) denote probabilities; [ ] denote standard errors

Table 2 reports the results for the best model, which is the model in which the constant is subject to regime change, while the variance and $DGDP_{-1}$ are not. Although this model succeeds in identifying the recessions in the early and mid-1980s, as well as the recessions in the early 1990s and 2009, it suffers from serious normality problems – the null-hypothesis of normality is convincingly rejected with a probability of only 0.8%.

Figure 1 – Regime-switching model for economic growth



Though the other three specifications do not suffer from normality and autocorrelation problems, they do not pick up the recessions. Table 3 shows that by not registering a regime change since at least 1986 none of the three alternative models pick up a recession for a thirty-year period.

Table 3 – Regimes identified by alternative MSvmodels for economic growth

Model	Regime 0	Quarters	Avg.prob.	Regime 1	Quarters	Avg.prob.
Constant and variance subject to regime switch	1986(3) - 2016(2)	120	0.994	1982(1) - 1986(2)	18	0.989
	Total: 120 quarters (86.96%) with average duration of 120 quarters			Total: 18 quarters (13.04%) with average duration of 18 quarters		
Constant, and lagged growth rate subject to regime switch	1983(1) - 1984(2)	6	0.993	1982(1) - 1982(4)	4	0.987
	1986(3) - 2016(2)	120	0.973	1984(3) - 1986(2)	8	0.928
	Total: 126 quarters (91.30%) with average duration of 63 quarters			Total: 12 quarters (8.70%) with average duration of 6 quarters		
Constant, lagged growth rate and variance subject to regime switch	1983(1) - 1984(2)	6	0.938	1982(1) - 1982(4)	4	0.991
	1986(3) - 2016(2)	120	0.976	1984(3) - 1986(2)	8	0.955
	Total: 126 quarters (91.30%) with average duration of 63 quarters			Total: 12 quarters (8.70%) with average duration of 6 quarters		

Note: Regime classification based on smoothed probabilities

The employment growth series also suffer from a number of shocks that undermine its normality (see Table 4). Four MS AR(1) employment growth models were run to explore the normality of the series and establish whether or not its regimes resemble the business cycle. Three of the models suffered from normality problems, while the regimes of the one that did not, did not show any regime switch between 1982 and 1997, a period with significant cyclical movements.

Table 4 – Regimes identified by alternative MS models for employment growth

Constant subject to	Regime 0	Quarters	Avg.prob.	Regime 0	Quarters	Avg.prob.
regime switch	1982(1) - 1990(1)	33	0.886	1990(2) - 1994(1)	16	0.830
	1994(2) - 1996(2)	9	0.641	1996(3) - 2003(2)	28	0.914
Normality χ^2-test	2003(3) - 2008(2)	20	0.923	2008(3) - 2010(1)	7	0.846
(prob): [0.0000]	2010(2) - 2013(1)	12	0.707	2013(2) - 2016(2)	13	0.770
	Total: 74 quarters (53.62%) with			Total: 64 quarters (46.38%) with		
	average duration of 18.50 quarters			average duration of 16.00 quarters		
Constant and variance	Regime 0	Quarters	Avg.prob.	Regime 0	Quarters	Avg.prob.
subject to regime	1983(1) - 1984(3)	7	0.803	1982(1) - 1982(4)	4	0.970
switch	1985(1) - 1990(1)	21	0.885	1984(4) - 1984(4)	1	0.544
	1994(3) - 1994(4)	2	0.523	1990(2) - 1994(2)	17	0.931
Normality χ^2-test	2003(3) - 2008(3)	21	0.907	1995(1) - 2003(2)	34	0.951
(prob): [0.0000]	2010(2) - 2012(2)	9	0.674	2008(4) - 2010(1)	6	0.943
	Total: 60 quarters (43.48%) with			2012(3) - 2016(2)	16	0.862
	average duration of 12.00 quarters.			Total: 78 quarters (56.52%) with		
				average duration of 13.00 quarters		
Constant, and lagged	Regime 0	Quarters	Avg.prob.	Regime 0	Quarters	Avg.prob.
growth rate subject to	1982(1) - 1997(4)	64	0.999	1998(1) - 1998(1)	1	0.999
regime switch	1998(2) - 2003(1)	20	0.999	2003(2) - 2003(2)	1	0.998
	2003(3) - 2008(4)	22	1.000	2009(1) - 2009(1)	1	0.975
Normality χ^2-test	2009(2) - 2014(2)	21	0.998	2014(3) - 2014(3)	1	1.000
(prob): [0.4011]	2014(4) - 2016(2)	7	0.972	Total: 4 quarters (2.90%) with		
	Total: 134 quarters (97.10%) with			average duration of 1.00 quarters		
	average duration of 26.80 quarters					
Constant, lagged	Regime 0	Quarters	Avg.prob.	Regime 0	Quarters	Avg.prob.
growth rate and	1983(1) - 1984(3)	7	0.798	1982(1) - 1982(4)	4	0.971
variance subject to	1985(1) - 1990(1)	21	0.883	1984(4) - 1984(4)	1	0.555
regime switch	1994(3) - 1994(4)	2	0.517	1990(2) - 1994(2)	17	0.932
	2003(3) - 2008(3)	21	0.906	1995(1) - 2003(2)	34	0.952
Normality χ^2-test	2010(2) - 2012(2)	9	0.668	2008(4) - 2010(1)	6	0.945
(prob): [0.0000]	Total: 60 quarters (43.48%) with			2012(3) - 2016(2)	16	0.866
	average duration of 12.00 quarters.			Total: 78 quarters (56.52%) with		
				average duration of 13.00 quarters		

Note: Regime classification based on smoothed probabilities

Both GDP and employment might have been subject to various shocks that distort and undermine the normality of the data. One way to deal with such shocks is to include dummy variables for the specific quarters that experienced shocks.[4] Instead of using an *ad hoc*, ocular approach to identify shocks (i.e. eyeballing the graph), a better approach is to run a General-to-specific (GETS) procedure separately for both GDP growth and employment growth, regressing them each on their respective lags, a constant, and so-called individual impulse saturation (IIS) dummies.

[4] Indeed, the example of a Markov-Switching model that Doornik (2013:22) uses in the PCGive guide includes a dummy for a shock.

Table 5 reports the results for both the GDP and employment estimations (they were run separately even though they are reported in the same table). Note that for both GDP and employment growth the GETS process retained the lags of the dependent variables. It also identified a list of shocks in the form of significant IIS dummies. However, both models have heteroscedasticity problems, indicating that the variability of both variables changes over time. This might be an indication of switching behaviour of these variables over time, which can be modelled using a MS-model. The IIS-dummies were subsequently included in the Markov-switching models in the hope that their inclusion will eliminate the normality problem. Table 6 report the results and indicate that, indeed, the normality problems have been fixed by the inclusion of the IIS dummies.

Table 5 – Identifying the shocks – the GETS-IIS procedure

	DGDP	DEmpl
$DGDP_{-1}$	0.588 (0.000)	
$DEmpl_{-1}$		0.271 (0.000)
Constant	0.003 (0.000)	0.002 (0.000)
1982(1)	-0.016 (0.002)	0.015 (0.003)
1982(4)	-0.024 (0.000)	
1983(4)	0.016 (0.003)	
1984(3)	-0.032 (0.000)	
1986(1)	-0.021 (0.000)	
1986(2)	0.011(0.034)	
1998(1)		-0.024 (0.000)
2003(2)		-0.023 (0.000)
2004(3)		0.014 (0.006)
2005(2)		0.014 (0.005)
2009(1)	-0.015 (0.004)	-0.020 (0.000)
2014(1)	-0.014 (0.008)	
2014(3)		-0.024 (0.000)
2016(2)		-0.013 (0.007)
Adj R^2	0.593	0.490
AR 1-5 F-test (prob)	0.999	0.485
ARCH 1-4 F-test (prob)	0.671	0.446
Normality χ^2-test (prob)	0.964	0.470
Hetero F-test (prob)	0.028	0.042
Hetero-X F-test (prob)	0.028	0.042
RESET23 F-test (prob)	0.687	0.031

Note: ( ) denote probabilities

Table 6 reports the model with the constant, $DGDP_{-1}$ and the variance all subject to regime change, while Figure 2 presents a visual depiction of the regimes.[5] The dummy for 1986(2) was omitted in the final model as it came out insignificant in all estimates. Notice that unlike the model reported in Table 1, the model reported in Table 6 does not suffer from normality problems. In terms of recessionary phases, Regime 0 represents the economic upswing phase (with a constant equals to 0.7%), while Regime 1 represents the recessionary phase (with a statistically insignificant

[5] The fixed variance model in which both the constant and $DGDP_{-1}$ are subject to regime change, gives very similar results (results available on request). The models in which the $DGDP_{-1}$ was not allowed to behave differently between the two regimes experienced autocorrelation problems.

constant). During recessions the AR-term has a larger parameter, meaning a fall in growth has a larger effect on the next period than during upswing phases.

Table 6 – Regime-switching model for economic growth using IIS dummies

$DGDP_{-1}(0)$	0.324 (0.000)			
$DGDP_{-1}(1)$	0.545 (0.000)			
Constant(0)	0.007 (0.000)			
Constant(1)	-0.001 (0.238)			
1982(1)	-0.012 (0.007)			
1982(4)	-0.020 (0.000)			
1983(4)	0.015 (0.000)			
1984(3)	-0.030 (0.000)			
1986(1)	-0.022 (0.000)			
2009(1)	-0.012 (0.008)			
2014(1)	0.015 (0.001)			
Other coefficients				
Sigma(0)	0.0040 [0.0003]			
Sigma(1)	0.0037 [0.0005]			
p_{0|0}	0.904 [0.0676]			
p_{1|1}	0.784 [0.0835]			
Linearity LR χ^2-test (prob)	0.024			
Normality χ^2-test (prob)	0.914			
ARCH 1-1 F-test (prob)	0.507			
Portmanteau χ^2-test (prob)	0.107			
	Regime 0,t		Regime 1,t	
Regime 0,t+1	0.904		0.216	
Regime 1,t+1	0.096		0.784	

Regime classification based on smoothed probabilities	Regime 0	Quarters	Avg.prob.	Regime 1	Quarters	Avg.prob.
	1983(2) - 1984(4)	7	0.990	1982(1) - 1983(1)	5	0.977
	1985(4) - 1988(4)	13	0.910	1985(1) - 1985(3)	3	0.918
	1993(1) - 1993(4)	4	0.905	1989(1) - 1992(4)	16	0.942
	1994(2) - 1996(4)	11	0.871	1994(1) - 1994(1)	1	0.540
	1999(1) - 2008(2)	38	0.953	1997(1) - 1998(4)	8	0.798
	2009(2) - 2014(4)	23	0.890	2008(3) - 2009(1)	3	0.930
	2016(2) - 2016(2)	1	0.967	2015(1) - 2016(1)	5	0.885
	Total: 97 quarters (70.29%) with average duration of 13.86 quarters			Total: 41 quarters (29.71%) with average duration of 5.86 quarters		

Note: ( ) denote probabilities; [ ] denote standard errors

Figure 3 compares the recessions identified by the MS-model with the recessions that the South African Reserve Bank (SARB) identified. The recessions identified by the MS-model largely overlap, and thus compare well with the recessions identified by the SARB method, with the MS-model's recessions typically shorter in nature. The recessions identified in this Markov-Switching AR(1) model, together with the recessions identified by the SARB, can now be used as benchmark against which to consider the model estimating the relationship between GDP and formal sector employment.

Figure 2 – MS-model for economic growth with IIS dummies

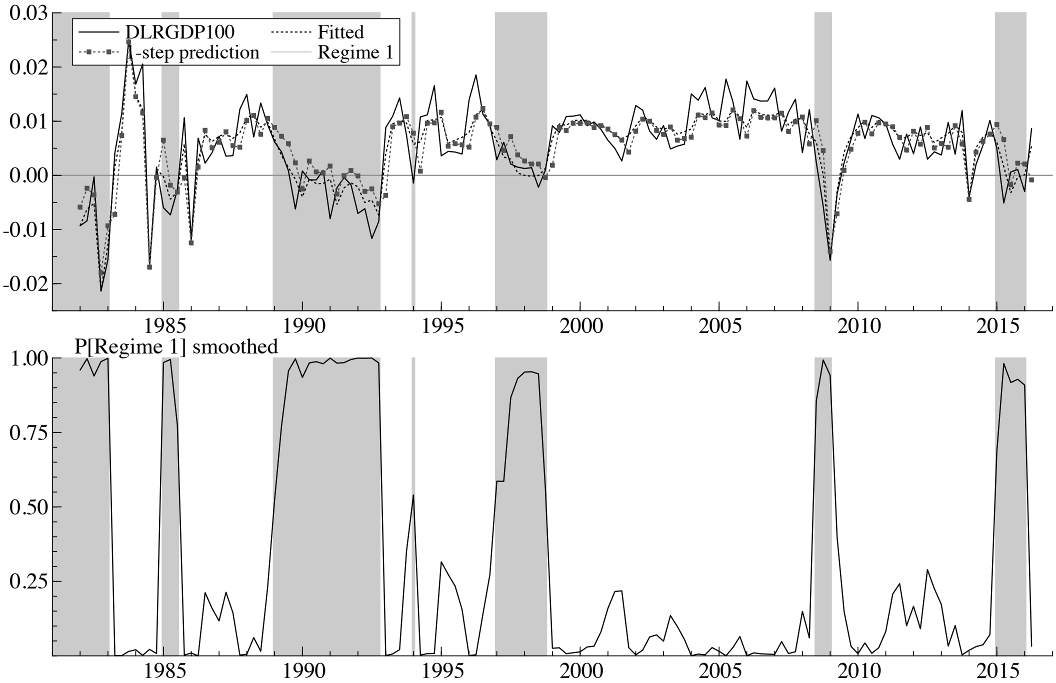
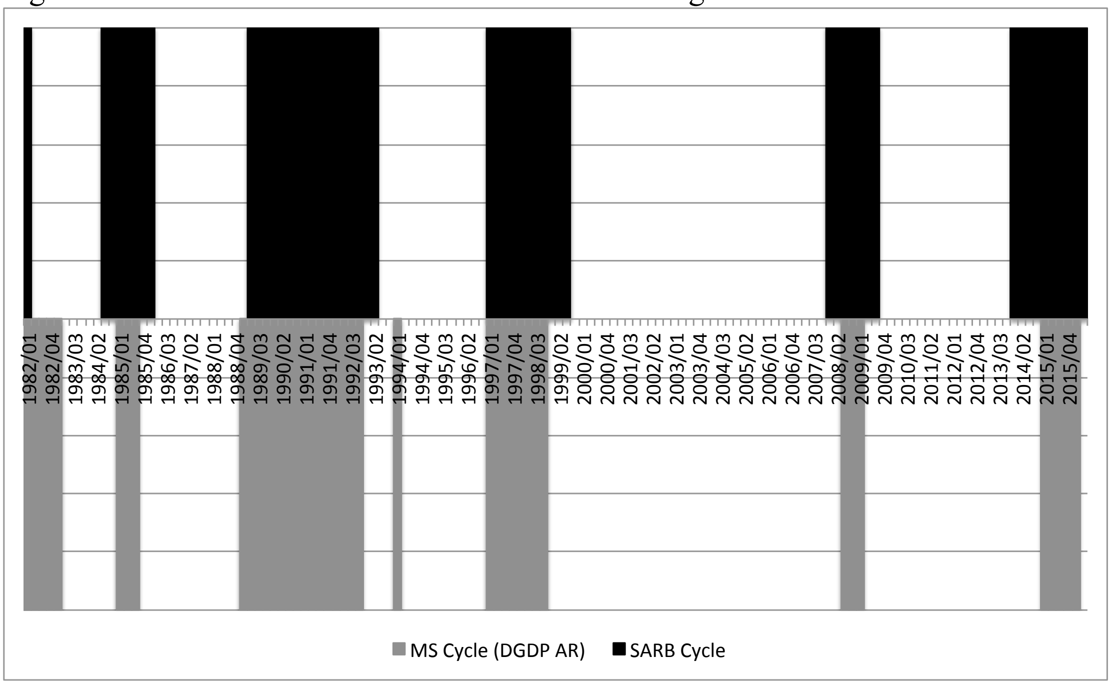


Figure 3 –Recessions of the MS-model for economic growth and SARB recessions



The employment-GDP MS-VEC model

Some studies exploring the relationship between employment and GDP merely estimate the relationship between GDP growth and employment growth. However, the levels of employment and GDP (in log form) are both non-stationary series – both are I(1) – suggesting the possible presence of a long-run relationship between the levels of employment and GDP. Thus, the analysis first estimates a long-run relationship between employment and GDP (see Table 7). It shows that in the long run a 1% change in GDP results in a 0.252% change in employment. This compares well with the finding by Kaseeram and Mahadea (2017:149) who found a 0.283% change for South Africa. Kaseeram and Mahadea (2017), though, did not account for non-linearities and non-normality in their estimates. The residual of this series, which is stationary at a 5% level with a KPSS value of 0.172 (against a critical value of 0.463), is subsequently used as error correction term in the short-run component of the model. An employment intensity of 0.252 is very low compared to the employment intensity in other countries discussed above.

Table 7 – MS-VECM model for employment growth using IIS dummies

Cointegrating equation	Empl
GDP	0.252 (0.000)
Constant	0.966 (0.000)

	DEmpl	DGDP
Error Correction Term$_{-1}$(0)	-0.033 (0.024)	-0.026 (0.100)
Error Correction Term$_{-1}$(1)	-0.028 (0.148)	0.020 (0.341)
DEmpl$_{-1}$(0)	0.261 (0.001)	0.193 (0.008)
DEmpl$_{-1}$(1)	0.006 (0.954)	-0.152 (0.182)
DGDP$_{-1}$(0)	0.226 (0.001)	0.286 (0.000)
DGDP$_{-1}$(1)	0.052 (0.644)	0.321 (0.010)
Constant(0)	0.000 (0.494)	0.006 (0.000)
Constant(1)	0.002 (0.031)	-0.002 (0.010)
1982(4)	-0.011 (0.017)	-0.018 (0.000)
1984(3)	-0.004 (0.428)	-0.032 (0.000)
1998(1)	-0.023 (0.000)	0.001 (0.846)
2003(2)	-0.025 (0.000)	-0.004 (0.402)
2004(3)	0.010 (0.018)	0.004 (0.380)
2005(2)	0.012 (0.005)	0.008 (0.067)
2009(1)	-0.016 (0.001)	-0.018 (0.005)
2014(3)	-0.020 (0.000)	0.009 (0.057)
2016(2)	-0.012 (0.009)	0.012 (0.008)

Other coefficients	
scale[0]	0.0042 [0.0003]
scale[1]	0.0042 [0.0003]
p_{0|0}	0.9306 [0.0316]
p_{1|1}	0.8301 [0.0697]
Linearity LR χ^2-test (prob)	0.000
Normality χ^2-test (prob)	0.358
ARCH 1-1 F-test (prob)	0.901
Portmanteau χ^2-test (prob)	0.136

	Regime 0,t	Regime 1,t
Regime 0,t+1	0.931	0.170
Regime 1,t+1	0.069	0.830

Regime classification based on smoothed probabilities	Regime 0	Quarters	Avg.prob.	Regime 1	Quarters	Avg.prob.
	1983(2) - 1984(4)	7	0.996	1982(2) - 1983(1)	4	0.987
	1985(4) - 1985(4)	1	0.904	1985(1) - 1985(3)	3	0.951
	1986(2) - 1989(2)	13	0.943	1986(1) - 1986(1)	1	0.998
	1993(1) - 1997(2)	18	0.939	1989(3) - 1992(4)	14	0.971
	1998(4) - 2008(2)	39	0.986	1997(3) - 1998(3)	5	0.784
	2009(1) - 2013(4)	20	0.975	2008(3) - 2008(4)	2	0.741
	Total: 98 quarters (71.53%) with average duration of 16.33 quarters			2014(1) - 2016(2)	10	0.983
				Total: 39 quarters (28.47%) with average duration of 5.57 quarters		

Note: ( ) denote probabilities; [ ] denote standard errors

In addition, during recessions the short-run relationship between output and employment breaks down, with the growth of output not exerting any influence on the growth of employment, while the IIS dummies denoting negative shocks occur either during recessions or very close to recessions, indicating the impact of negative shocks related to recessions.

Figure 4 – MS-VEC model for employment growth using IIS dummies

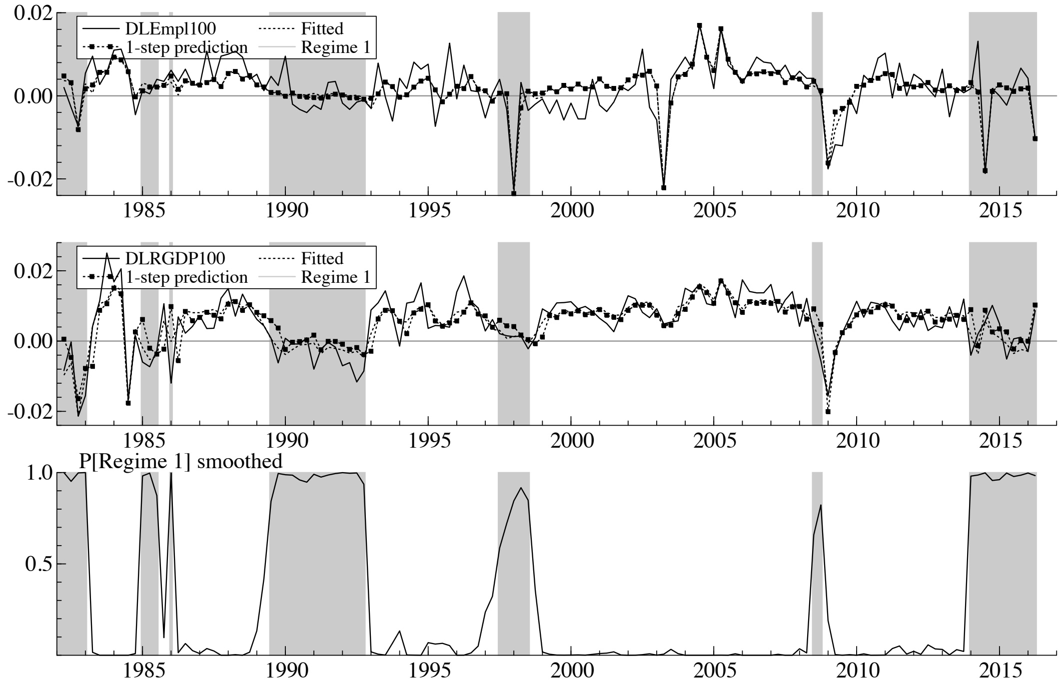


Figure 5 –Recessions of the MS-VEC model and SARB recessions

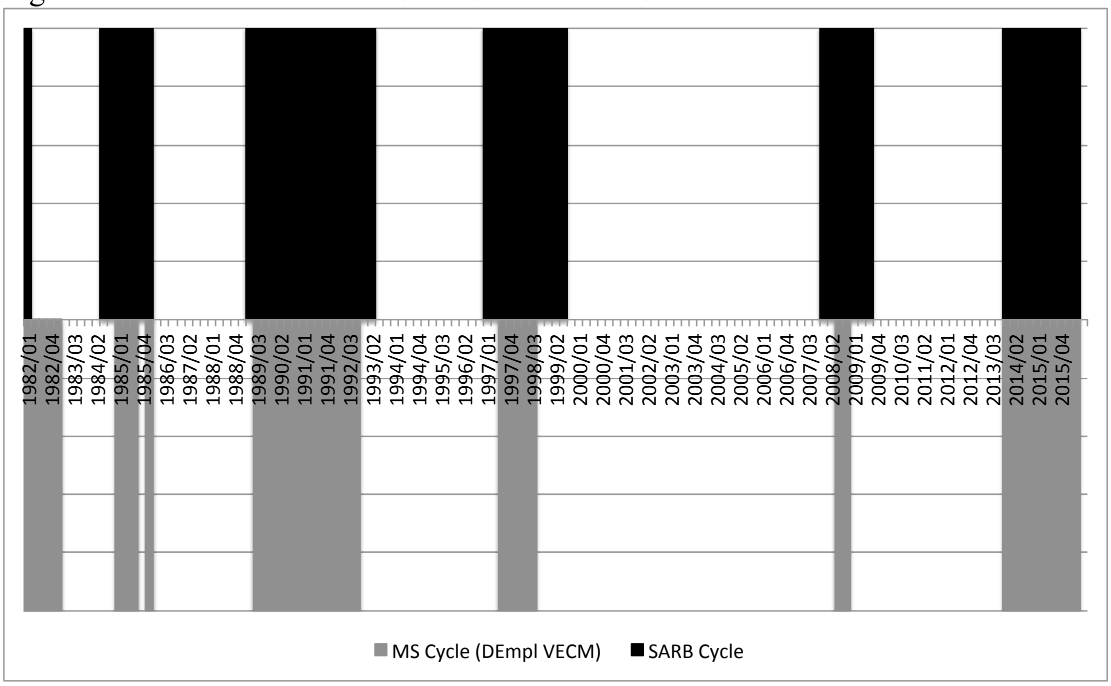


Figure 4 presents the regimes of the MS-VEC model, while Figure 5 shows that the recessions coincide well with the recessions identified by the SARB. They also compare well with the recessions of the MS model for economic growth reported in Table 6 and Figure 3. Thus, what the MS-VEC model shows is that there is indeed a cyclical dimension to the relationship between output and employment. During booms there is a short-run relationship between the growth of employment and the growth of output, while the growth of employment also adjusts to deviations from the long-run relationship between output and employment. During recessionary phases all of this breaks down. Also notable is that during upswings the growth in employment impacts the growth in output. However, again, this breaks down during recessions.

Conclusion

This article set out to establish whether or not higher economic growth leads to higher employment growth. The results show that there is a long-run relationship between output and employment and that higher output leads to higher employment. The employment intensity, though, is rather low relative to international experience. Also in the short-run does a higher economic growth rate results in a higher growth of employment. However, during recessions the relationship breaks down. Furthermore, during economic upswings higher employment growth also results in higher economic growth, indicating a reverse causation. With economic growth falling from more than 5% in the mid-2000 to less than 0.5% in 2016 the lack of employment growth, however, cannot only be ascribed to a low employment intensity. It also results from low economic growth. The role for economic policy would therefore be to address both the low economic growth rate and the low employment intensity.

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