Reconsidering the business cycle and stabilisation policies in South Africa

Stan du Plessis[1]

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[1] Department of Economics, University of Stellenbosch

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ABSTRACT: This paper applies an alternative dating algorithm - suggested by Harding and Pagan (for example, 2002a) - to identify the turning points of the South African business cycle. The characteristics of the resulting business cycle are analysed and compared with results obtained for the official cycle in recent papers on the South African business cycle (du Plessis and Smit, 2003; du Plessis, 2004). The alternative business cycle has plausible characteristics and provides supporting evidence for the thesis that monetary policy has been used more consistently to dampen the cycle of economic activity in South Africa since the early nineties. JEL CLASSIFICATIONS:: C14; C41; E32

*Department of Economics, University of Stellenbosch

1 Introduction

In South Africa, as elsewhere, a series of official turning points are defined that separate the phases of the business cycle. This method follows the seminal work of Burns and Mitchell (1946) which remains widely used by dating committees in many countries, for example the USA and South Africa (Mohr, van der Merwe, Botha and Inggs, 1989). However, recent academic work has discounted the Burns-Mitchell method with the argument that it does not generate statistics with "well-defined statistical properties" (Blanchard and Fischer, 1989).

Don Harding and Adrian Pagan [1] have recently stimulated renewed interest in the Burns-Mitchell method with a series of articles in which they demonstrated that the statistical foundations of a dating algorithm can be described formally, and that such algorithms may be attractively robust and practical tools for identifying the phases of the cycle.

This paper followed Harding and Pagan's method (described in section 2) and used it to find a set of turning points for the South African business cycle in section 3. Various aspects of the business cycle (so defined) are described in section 4, while section 5 extends the discussion to stabilisation policy from the monetary and fiscal side.

1.1 A non-parametric method for dating the business cycle

Early views of the business cycle conceptualised what Mitchell called "alternate periods of activity and sluggishness" in the economic system, or the "rhythm of business activity" as he also called it (Mitchell, 1923). Three aspects of this early conceptualisation stand out: firstly, the phases of the business cycle are associated with "relatively prosperous and depressed times" which matches the intuitive understanding of non-academic observers more easily than it does with the stochastic approach commonly used in contemporary academic research. Secondly, censoring rules were used to ensure that identified cycles (and phases of each cycle) satisfied some minim duration requirements in terms of duration.

Thirdly, the business cycle refers to the total economic system, or aggre-

[1] See for example Harding and Pagan (2001; 2002b; 2002a; 2002c; 2005a) and Harding (2002).

gate economic activity. Burns and Mitchell and others of their era did not have access to reliable time series of gross domestic product as a summary of economic activity,[2] and that is why these pioneers of formal business cycle analysis found it "...necessary to have recourse to other statistical series, which are either themselves constituent parts of the index of production, or are empirically so closely related that they can be taken as highly symptomatic for the direction of the movement or magnitude of fluctuations in the fundamental series" (Haberler, 1958: 270). With the availability of data on aggregate economic activity the case for analysing the co-movements in many series (often summarised in a reference cycle), as opposed to analysing the cycle of aggregate activity directly, is undermined.

Assuming that GDP is an adequate summary of aggregate economic activity, Harding and Pagan (2002a) distinguished between parametric and non-parametric methods for identifying the tuning points of this single series. Amongst the parametric approaches, Markov switching models have achieved prominence and was recently applied to the South African case by Moolman (2004). Bry and Boschan's algorithm, proposed by Pagan and Harding (2002a), is an example of non-parametric dating method and it is the method used in this paper.

The dating algorithm used here is by Bry and Boschan (1971) as suggested by Harding and Pagan in various recent papers. This algorithm identifies local minima (troughs) and local maxima (peaks) in a single time series, or $\{y_t\}$ after a log transformation.[3] Peaks are found where y_s is larger than k values of $\{y_t\}$ in both directions $[t-k, t+k]$ and troughs where y_s is smaller than k values of $\{y_t\}$ in both directions. The size of k is set by the censoring rule of the algorithm. There is no optimal size for k, but Bry and Boschan (1971) suggested a value of 5 at a monthly frequency which Harding and Pagan (2001) translated to 2 for quarterly series.

A censoring rule is also required to ensure that each cycle (and each of its phases) have a minimum duration. Following Harding and Pagan (2001) the minimum duration for a single phase was set at 2 quarters and the minimum duration for a complete cycle at 5 quarters.

The Bry-Boschan algorithm therefore identifies turning points according to the requirements in equation 1, subject to the above mentioned censoring

[2] Burns and Mitchell (1946) were concerned with the accuracy of the GDP data which had just become available at the time of their study. See Harding (2002) for a more detailed account of this issue.

[3] The algorithm is invariant to such a log transformation (Harding and Pagan, 2001)

rules.

$$\begin{aligned} &\text{Peak at t if } \{(y_{t-2}, y_{t-1}) < y_t > (y_{t+1}, y_{t+2})\} \\ &\text{Trough at t if } \{(y_{t-2}, y_{t-1}) > y_t < (y_{t+1}, y_{t+2})\} \end{aligned} \tag{1}$$

The application of this algorithm to South African GDP data was problematic during the sixties and the nineties; both periods of steady expansion, even if the expansion of the sixties was more impressive than that of the nineties. During both periods the algorithm struggled to identify turning points, implying cycles of unrealistically long duration. Harding and Pagan (2001) discussed this possibility as well as using a transformed series $\{z_t\}$ that is more sensitive to changes in the rate of economic growth than $\{y_t\}$. One such transformation is to subtract a simple deterministic linear trend from $\{y_t\}$ and that was done in the application reported here, which yields a growth cycle as opposed to a classical cycle.[4]

Once the turning points of the cycle have been identified it is possible to describe the characteristics of the cycle in terms of duration, amplitude, steepness, non-linearity, and synchronisation with the business cycles of other economies or of the phases of cyclical patterns in other macroeconomic magnitudes within the same economy.

2 Alternative turning points for the South African business cycle

Table 1 shows the official turning points for the South African business cycle listed on table S-151 of the South African Reserve Bank's Quarterly Bulletin (for example, South African Reserve Bank, 2002).

Figure 1 shows a graphical comparison of the official phases of the South African business cycle and the phases of the cycle derived using the BBQ algorithm. The dark areas indicate expansions with contractions indicated by the light areas on the graph. The official cycle is shown in the bottom

[4]Harding and Pagan (2001) recommended subtracting a deterministic trend if any components is to be removed. They argued that this process neither loses nor gains any information about the turning points. Since an algorithm is used to replicate the official turning points in a transparent and intuitive manner, the relevant question is whether this transformation yields plausible turning points for aggregate economic activity. In the South African context this is answered in the affirmative below.

pane and the BBQ cycle in the top pane. Figure 1 also shows the quarter-on-quarter (annualised) GDP growth rates (right hand scale).

Table 3 provides a descriptive summary of the duration characteristics of the cycle defined by the official turning points as well as by the BBQ algorithm.

From figure 1 and table 3 the approximation to the South African business cycle derived here seems fairly accurate, a conclusion which can be formalised with the concordance index suggested by Bry and Boschan (1971) and more recently by Harding and Pagan (2002b; 2005b). This index measures the proportion of time both business cycle algorithms (SARB and BBQ) indicate the same phase of the cycle.[5]

The concordance index is 1 when the two algorithms yield perfectly positively synchronised cycles, and 0 when the cycles are perfectly negatively synchronised. A score of 0.5 indicates no evidence of synchronisation. However, this index is likely to be biased upwards with business cycle phase data due to the long periods spent in each phase. A mean correction of the concordance index avoids this potential bias and after rescaling the mean corrected concordance index ranges between 1 (perfect positive correspondence) to -1 (perfect negative correspondence). It is also possible to test the significance of the comovement using the method suggested by Haring and Pagan (2005b).[6]

In the case of the SARB and BBQ algorithms the resulting cycles score 0.6 on the mean adjusted concordance index, suggesting that the cycles are synchronised to a high degree and highly significant statistically.

But there are also some differences between the SARB and BBQ cycles, including: Firstly, the average duration of (especially) contractions is shorter with the BBQ algorithm than in the official series, whereas expansions have a similar average duration. The result is a shorter cycle on average with the BBQ algorithm. This is interesting in light of du Plessis's (2004) conclusion that the apparent lengthening of the official business cycle in South Africa

[5] One advantage of this measure of synchronisation is that it can be used even when the two series are non-stationary (Harding and Pagan, 2002b)

[6] Harding and Pagan (2005b) that the coefficient s in the following equation is proportional to the mean adjusted correspondence index and provided that heteroskedastic and autocorrelation consistent (HAC) estimated of the standard errors are sued the significance of the comovement between he series can be tested with a significance test on ρ_s. The Newey-West procedure for HAC standard errors was followed here.

$$\left(\frac{S_{y,t}}{\sigma_{sy}}\right) = \eta + \rho_s \left(\frac{S_{x,t}}{\sigma_{sx}}\right) + u_t$$

since the early seventies was mainly due to longer contractions. If the BBQ algorithm measured the duration of contractions more accurately over this period, then the "stretching" of the South African business cycle observed in du Plessis (2004) might be explained as a by-product of the dating algorithm used by the SARB.

Secondly, the minimum duration of contractions is much shorter using the BBQ algorithm, though the minimum duration for expansions and the respective maxima are comparable. Thirdly, the official cycle spends relatively more time in contractions and less time in expansions than is the case with the BBQ algorithm.

Fourthly, the duration of expansions relative to preceding contractions is larger for the BBQ algorithm (1.44) than for the official cycle (1.13). Finally, both on weighted and unweighted averages the BBQ cycle records higher average growth during expansions and lower average growth during contractions than the official cycle.

Though there are differences between the BBQ and official cycle the differences do not cast a poor light on the BBQ cycle. On the contrary, the BBQ cycle seems to capture periods of expansion and contraction slightly more intuitively than the official cycle, and this accords with the "common usage" of what a dating algorithm should do (Harding and Pagan, 2002c).

Having established at least the initial plausibility of the BBQ method, its usage could now be extended to other series, locally and internationally, to enable a thorough description of the domestic and international features of the South African business cycle. Table 4 shows the series for which turning points were identified using the BBQ method.

3 Empirical observations about the business cycle in South Africa

Macroeconomists are interested in at least four characteristics of the cyclical pattern (Harding and Pagan, 2002b): the duration data for the cycle and each phase separately, the amplitude of each phase, the shape and symmetry of each phase, and, finally, the cumulative changes in each phase. The duration data and cumulative changes have been reported in table 3, but some technique is required to measure the amplitude, steepness and possible non-linearities of the business cycle.

3.1 Duration characteristics

Frank (2001) and du Plessis (2004) recently examined the duration dependence of the South African business cycle using parametric and non-parametric techniques respectively. Neither the parametric test in Frank (2001) parametric test nor the non-parametric tests in du Plessis (2004) showed evidence of duration dependence for the post-War period.[7] However, du Plessis (2004) also considered pre- and post-1973 sub-samples and found evidence that post-1973 contractions had lost the positive duration dependence that it had during the earlier period, which could be one reason for the "stretching" of contractions observed in South Africa since 1973. It would be instructive to investigate whether the same result also holds for the turning points identified by the BBQ algorithm.

A hazard function shows the conditional probability that an event will end at time t, given that it has lasted up to that point. If the hazard function is itself a function of time then the underlying event is "duration dependent". For example, if the hazard function for contractions is a positive function of time, then contractions have positive duration dependence; that it, the probability of a trough increases with the duration of a contraction.

A hazard function with exponential distribution does not exhibit duration dependence, making the exponential distribution a convenient null hypothesis for our purposes. Shapiro and Wilk (1972) suggested an exact non-parametric test for this null, and their W-test was extended by Stephens (1978) to incorporate the censoring rules used above. The results of these tests for the SARB and BBW cycles (and their phases) are shown in Table 5.

From table there is no evidence of duration dependence for the BBQ cycle, which is also the case for the SARB cycle and concurs with the results in Frank (2001) and du Plessis (2004).

3.2 Amplitude and symmetry

Harding and Pagan (2001) suggested some sample mean estimators for the amplitude and symmetry of the business cycle and its phases. The average

[7] This contrasts with the experience in the UK and US as examined by for example Diebold and Rudebusch (1999) and Mudambi and Taylor (1995)

amplitude of each phase is given by the metric in equation 2.

$$\hat{A} = \frac{\sum_{t=1}^{T} s_t \Delta y_t}{NTP} \tag{2}$$

Where:

NTP: number of turning points

As a measure of the steepness of each phase Harding and Pagan (2001) suggested the ratio of the average amplitude to the average duration of the phase, as shown in equation 3.

$$\text{STEEP} = \frac{\hat{A}}{\hat{D}} = \frac{\sum_{t=1}^{T} s_t \Delta y_t}{\sum_{t=1}^{T} s_t} \tag{3}$$

The linearity (or otherwise) of each phase of the cycle is also of interest. Harding and Pagan (2001) suggested a comparison of the cumulative change in the first half of the phase with the same in the second half as a measure of the non-linearity of each specific phase, as per equation 4 below. The metric v_i will be positive if the first half of the phase recorded more rapid growth (or contraction) than the second half.

$$v_i = \frac{1}{\frac{d_i}{2}} \left[\sum_{k=1}^{\frac{d_i}{2}} (y_{k+t_i} - y_{k+t_i-1}) - \sum_{k=\frac{d_i}{2}}^{d_i} (y_{k+t_i} - y_{k+t_i-1}) \right] \tag{4}$$

A measure of the average non-linearity of the phases can be defined by averaging over the $\{v_i\}$. It seems reasonable to follow Harding and Pagan's (2001) suggestion of a weighted average that gives more weight to longer cycles, as shown in equation 5.

$$= \frac{1}{N} \sum_i \left(\frac{d_i}{N} \right) v_i \tag{5}$$

The observed values of these metrics, given the BBQ business cycle, are reported in table 6.

The results in table 6 can be compared with the results reported for growth cycles in various developed countries (the USA and some from Europe) in Harding and Pagan (2001) and shown in table 7.

Expansions in South Africa have a considerably larger amplitude than the developed countries in this sample. Since the average duration for South African expansions are comparable to those observed in table 7, the large amplitude also implies that South African expansions are considerably steeper than in the sample of developing countries reported in Harding and Pagan (2001).

In contrast, contractions in South Africa have a much lower amplitude than the developed countries in table 7. With a comparable average duration for contractions it follows that contractions are less steep in South African than in the developed countries analysed by Harding and Pagan (2001). On an international comparison, then, the South African business cycle as dated with the BBQ algorithm is characterised by shallow contractions and steep expansions.

The "shape" indicators in tables 6 also yield interesting information about the BBQ cycle in South Africa: the negative coefficient for expansions indicates that, on average, the second halves of expansions are steeper than the first halves. The positive coefficient on the shape metric for contractions suggests a similar pattern with a sharper decline in the second half of an expansion than during the first half.

Drawing together the characteristics as measured above we can describe the average phases of the South African business cycle as follows:

1. Contractions are fairly long in duration, and combined with modest amplitude this yields a fairly shallow decline in activity which gathers pace during the second half of a contraction.

2. Expansions have an average duration, and combined with a large amplitude this yields a fairly steep rise in activity which gathers pace during the second half of an expansion.

A further step in characterising the empirical characteristics of the business cycle in South Africa is to consider the extent to which various other macroeconomic magnitudes share the cyclical behaviour observed for aggregate economic activity. The concordance index used in the previous section to measure the concordance between the rival definitions of the business cycle was also used to measure the concordance with other macroeconomic magnitudes. Table 8 reports the mean adjusted concordance indices between these magnitudes and the BBQ cycle in South Africa, and also indicates where these relationships are statistically significant.

There are no surprises in the first third of this table which shows greater concordance for consumption and imports (both of which are also significant) than for investment expenditure and exports (with relationships not significant at the conventional levels). From the relatively low concordance of the export and output cycles - combined with modest international capital flows to South Africa over much of the period - one would predict that the local output cycle shows little concordance with business cycles elsewhere. Such a prediction is borne out in table 8 which shows relatively low concordance of the South African cycle with either US or EMU growth cycles. This conclusions was not affected by allowing for a lag in the transmission between the output cycles in these economies and the South African output cycle.

Both manufacturing and the tertiary sector show a high degree of concordance with the aggregate cycle, while the primary sector is more often desynchronised. These results are not surprising given the composition of output by the South African economy.

4 Stabilisation policy

Intuitively, stabilising monetary and fiscal policies ought to move against the business cycle. And this is precisely what Christina and David Romer found for the USA where real (and nominal) interest rates moved pro-cyclically and the stance of fiscal policy counter cyclically after peaks and troughs in economic activity (Romer and Romer, 1994; Romer, 1999). Du Plessis and Smit (2003) applied the Romers's method to the official business cycle in South Africa, but found little evidence of stabilising changes to either monetary or fiscal policy instruments since the seventies.

An alternative measure of stabilisation policy would be to identify turning points for nominal and real interest rates and for a measure of the fiscal stance. Stabilising monetary policy would then imply that the interest rate cycle be in the same phase as economic activity, while the opposite phase from economic activity would indicate counter-cyclical fiscal policy.

The BBQ algorithm was used to find the turning points in the cycle of short term nominal interest rates. Since the stance of monetary policy is more appropriately measured by the real interest rate, the method of the Romers was used to construct a real interest rate series. This method involves three steps, of which the first is to define an ex post real interest rate as per

equation (6) (Romer and Romer, 1994).

$$r_t^{\text{ex post}} = i_t - 400x \left[\ln \left(\frac{P_{t+1} + P_t}{2} \right) - \ln \left(\frac{P_t + P_{t-1}}{2} \right) \right] \tag{6}$$

where:

$r_t^{\text{ex post}}$: the *expost* real interest rate

i_t : the nominal interest rate

P_t : the consumer price index

In a second step this *ex post* real interest rate is regressed on the nominal interest rate, inflation and real GDP growth in a distributed lag function with four lags. The fitted values for the dependent variable defines the *ex ante* real interest rate in step 3. Figure 2 compares this *ex ante* real interest rate with the more conventional backward-looking real interest rate: $r_t^{\text{convential}} = i_t - 100x \left(\frac{P_t}{P_{t-4}} - 1 \right)$.

It does not seem as if the Romers's method will yield answers in sharp contrast with the conventional approach. Table 9 below reports the concordance index between phases in the cycle of real and nominal short-term interest rates and the phases of the growth cycle.

The part of fiscal policy that could reasonably be identified with stabilisation policy is unobserved and difficult to construct. Christina and David Romer (1994) had the advantage of an employment adjusted budget deficit in the USA, which is unavailable for South Africa. And it would be inappropriate to use an unadjusted budget deficit given the significant impact of the cycle on government revenue. For this reason I follow Fatás and Mihov (2003) who defined discretionary fiscal policy with government expenditure. The BBQ algorithm was then used to calculate turning points for the government expenditure to GDP ratio to identify the fiscal policy cycle for South Africa. The concordance between this cycle and the growth cycle is again reported in table 9.

The concordance indices reported in table 9 suggests the contemporaneous nominal interest rate has moved pro-cyclically (which is required for a stabilising effect of monetary policy), but nominal interest rates did not move sufficiently to generate pro-cyclical contemporaneous real interest rates.

Due to the long and variable lags of the transmission mechanism monetary policy operates optimally in a forward-looking manner. It is, consequently, important to investigate the concordance of the real interest rate with the business cycle at some horizon representing the transmission mechanism.

This possibility was investigated at two horizons; with monetary policy being forward-looking at a horizon of 4 quarters and 6 quarters respectively. As seen in table 9, neither of these alternatives yield evidence of pro-cyclical real interest rates.

It might nevertheless be instructive to construct a figure showing the periods where real interest rates have, in fact, been pro-cyclical. To that end figure 3 shows periods of pro-cyclical forward-looking real interest rates.

Figure 3 shows clearly why the concordance index records such a low value for the association between measures of forward-looking monetary policy and the GDP cycle. However the figure also shows two rather distinct periods, with the pre-1990 area showing very little evidence of stabilising monetary policy, while the post-1990 period shows considerable evidence of stabilising monetary policy on both measures of forward-looking policy.

The extent to which the post-1990 period is different can be seen formally in table 9 where the concordance index between the GDP cycle (lagged by 4 and 6 quarters respectively) and the real interest rate is shown. At both these lags real interest rates moved significantly pro-cyclically; that is forward-looking monetary policy was consistent with the phase requirement for stabilisation policy.

Turning to fiscal policy, the concordance measure of the fiscal policy cycle and the growth cycle suggest that the stance of fiscal policy (as measured) may have contributed modestly to a more stable business cycle in South Africa. Both the contemporaneous column and the columns that allow for outside lags of 4 and 6 quarters show statistically significant anti-cyclical fiscal policy of comparable modest order.

5 Conclusion

The primary goal of this paper was to identify an alternative set of turning points for the South African business cycle, using a simple, transparent and repeatable algorithm that would also facilitate international comparisons. This yielded an intuitively plausible alternative business cycle, with the following features: Firstly, fairly long, shallow, contractions which gathers pace during the second half of a contraction. Secondly, expansions of average duration that rise steeply, especially in the latter half of an expansion. Thirdly, no evidence of duration dependence in the cycle or either of its phases and, finally, the South African business cycle shows little concordance with growth

cycles in the USA or EMU.

Finally, the presence of anti-cyclical monetary and/or fiscal policy was examined by identifying cycles in relevant measures of these policies. This analysis did not uncover evidence of contemporaneous anti-cyclical monetary policy in South African since the early seventies, nor of forward-looking anti-cyclical policy for the same period. However, the ability of the SARB to conduct stabilising forward-looking monetary policy seems to have evolved over the period as the nineties show considerable evidence of forward-looking anti-cyclical monetary policy. Finally, the evidence presented suggests that fiscal policy has been a modestly stabilising influence throughout the period.

References

Blanchard, O. J. and S. Fischer (1989). *Lectures on macroeconomics*. Cambridge, Ma., The MIT Press.

Bry, G. and C. Boschan (1971). *Cyclical analysis of time series: selected procedures and computer programmes*. New York, National bureau of Economic Research.

Burns, A. F. and W. C. Mitchell (1946). *Measuring business cycles*. New York, National Bureau of Economic Research.

Diebold, F. X. and G. D. Rudebusch (1999). *Business cycles: durations, dynamics and forecasting*. Princeton, NJ., Princeton University Press.

du Plessis, S. A. (2004). "Stretching the South African Business Cycle." *Economic Modelling* 21(1): 685-701.

du Plessis, S. A. and B. W. Smit (2003). Stabilisation policy. Stellenbosch, Paper presented at the eight annual conference for econometric modelling in Africa.

Fatás , A. and I. Mihov (2003). "The case for restricting fiscal policy discretion." *Quarterly Journal of Economics* 2003(November): 1419-1447.

Frank, A. G. (2001). "Is the South African business cycle time dependent?" *South African Journal of Economic and Management Sciences* 4: 204-215.

Haberler, G. (1958). *Prosperity and depression. A theoretical analysis of cyclical movements (third edition)*. London, George Allen & Unwin Ltd.

Harding, D. (2002). The Australian business cycle: a new view. Melbourne, Melbourne Institute of Applied Economics and Social Research.

Harding, D. and A. Pagan (2001). Extracting, analysing and using cyclical information. Melbourne, Melbourne Institute of Applied Economics and Social Research.

Harding, D. and A. Pagan (2002a). "A comparison of two business cycle dating methods." *Journal of Economic Dynamics and Control* 27: 1681-1690.

Harding, D. and A. Pagan (2002b). "Dissecting the cycle: a methodological investigation." *Journal of Monetary Economics* 49: 365-381.

Harding, D. and A. Pagan (2002c). "Rejoinder to James Hamilton." *Journal of Economic Dynamics and Control* 27: 1695-1698.

Harding, D. and A. Pagan (2005a). "A suggested framework for classifying the modes of cycle research." *Journal of applied econometrics* 20(2): 151-159.

Harding, D. and A. Pagan (2005b). "Synchronisation of cycles." *Journal of Econometrics* Article in Press.

Mitchell, W. C. (1923). *Business cycles and unemployment*. New York, National Bureau of Economic Research.

Mohr, P., C. van der Merwe, et al. (1989). *Die praktiese gids tot Ekonomiese Aanwysers*. Johannesburg, Lexicon Uitgewers.

Moolman, E. (2004). "A Markov switching regime model of the South African business cycle." *Economic Modelling* 21(4): 631-646.

Mudambi, R. and L. W. Taylor (1995). "Some non-parametric tests for duration dependence: an application go UK business cycle data." *Journal of Applied Statistics* 22(1): 163-177.

Romer, C. D. (1999). "Changes in business cycles: evidence and explanations." *Journal of Economic Perspectives* 13(2): 23-44.

Romer, C. D. and D. H. Romer (1994). What ends recessions? Boston, Ma., NBER working paper, 4765.

Shapiro, S. and M. B. Wilk (1972). "An analysis of variance test for the exponential distribution." *Technometrics* 14(2): 355-370.

South African Reserve Bank (2002). *Quarterly Bulletin* March 2002: S-147.

Stephens, M. A. (1978). "On the W-test for exponentiality with origin known." *Technometrics* 20(1): 33-35.

Table 1: Official turning points for the South African economy

Contractions Period	Duration in quarters	Expansions Period	Duration in quarters	Total duration in (months)
1971:Q1-1972:Q3	7	1972:Q4-1974:Q3	8	15
1974:Q4-1977:Q4	13	1978:Q1-1981:Q3	15	28
1981:Q4-1983:Q1	6	1983:Q2-1984:Q2	5	11
1984:Q3-1986:Q1	7	1986:Q2-1989:Q1	12	19
1989:Q2-1993:Q2	17	1993:Q3-1996:Q4	14	31
1997:Q1-1999:Q3	11	1999:Q4-	17(+)	28(+)

Table 2: Turning points using the BBQ algorithm

Contractions Period	Duration in quarters	Expansions Period	Duration in quarters	Total duration in (months)
1971:Q2-1972:Q1	4	1972:Q2-1974:Q3	10	14
1974:Q4-1975:Q1	2	1975:Q2-1876:Q1	4	6
1976:Q2-1977:Q3	6	1977:Q4-1981:Q4	17	23
1982:Q1-1983:Q2	6	1983:Q3-1984:Q2	4	10
1984:Q3-1986:Q4	10	1987:Q1-1989:Q1	9	19
1989:Q2-1992:Q4	15	1993:Q1-1994:Q4	8	23
1995:Q1-1995:Q4	4	1996:Q1-1996:Q4	4	8
1997:Q1-1998:Q4	8	1999:Q1-2001:Q1	9	17
2001:Q2-2001:Q3	2	2001:Q4 (+)		

Table 3: Duration characteristics of the official and BBQ cycles

Characteristic	Contraction		Expansion		Total	
	SARB	BBQ	SARB	BBQ	SARB	BBQ
Average duration	10.2	6.3	10.8	8.1	20.8	15.9
Median duration	9	6	12	8.5	19	16.5
Max duration	17	15	15	17	31	24
Min duration	6	2	5	4	11	6
Proportion[a]	44.9	42.2	55.1	57.8		
Expansion:contraction ratio[b]					1.13	1.44
Average GDP growth (unweighted)	-0.21	-0.37	4.36	4.83		
Average GDP growth (weighted)[c]	-0.001	-0.59	3.89	4.61		

a Proportion of time spent in either phase, measured up to 2004Q4

b Average duration of an expansion relative to preceding contraction

c The average GDP growth of each phase weighted with the duration of that phase (d_i) relative to the total time spent in the phase, i.e. (d_i/E) or (d_i/C) where E and C are the total number of quarters spent in expansion or contraction.

Table 4: List of series for which turning points were identified

Components of aggregate demand	Value added per sector	International linkages	Policy variables
Gross fixed capital formation	Primary sector	USA GDP	Nominal interest rate
Consumption expenditure	Manufacturing	EMU GDP	Real interest rate
Exports	Electricity, gas and water		Government expenditure
Imports	Construction		
	Tertiary sector		
	Financial, property and business services		

Table 5: Non-parametric tests for duration dependence

	SARB		BBQ	
	W	$W(t_0 = \gamma)^a$	W	$W(t_0 = \gamma)^b$
Expansions	0.594	0.284	0.150	0.186
Contractions	0.224	0.138	0.228	0.151
Total cycle	0.416	0.217	0.297	0.219

a: The shortest observed expansion, contraction and total cycle were used as a measure of g for the SARB's cycle.

b: The censuring rules of section 1 determined γ for the BBQ cycle, i.e. 2 quarters for an expansion or contraction and 5 quarters for a total cycle.

Table 6: Characteristics of the SA business cycle

Characteristic	Expansions	Contractions
Amplitude (%)	9.85	-1.11
Steepness	1.09	-0.15
Shape of the cycle	-0.002	0.001

Table 7: International comparison of business cycle characteristics

Characteristic				
	Expansions	Contractions	Expansions	Contractions
	Germany		*France*	
Duration	9.17	9.00	6.57	7.00
Amplitude (%)	4.13	-4.04	2.56	-3.12
Steepness	0.45	-0.45	0.39	-0.45
Italy	*Spain*		*Germany*	
Duration	7.25	6.38	10.14	4.86
Amplitude (%)	4.04	-4.05	3.00	-2.06
Steepness	0.56	-0.63	0.30	-0.42
	Netherlands		*Austria*	
Duration	4.75	5.56	5.67	10.5
Amplitude (%)	3.30	-3.21	3.34	-4.21
Steepness	0.69	0.58	0.50	-0.40
	EMU		*USA*	
Duration	7.20	9.33	6.88	5.38
Amplitude (%)	2.95	-3.35	4.02	-3.82
Steepness	0.41	-0.36	0.58	0.71

Table 8: Concordance of various macroeconomic magnitudes

Magnitude	Concordance with South African business cycle		
Components of aggregate demand			
Gross fixed capital formation	0.19 (0.136)		
Consumption expenditure	0.41 (0.000)***		
Exports	0.14 (0.169)		
Imports	0.28 (0.008)***		
Value added by sector			
Primary sector	0.25 (0.033)**		
Manufacturing	0.59 (0.000)***		
Electricity, gas and water	0.30 (0.058)*		
Construction	0.25 (0.030)**		
Tertiary sector	0.59 (0.000)***		
Financial, property and business services	0.43 (0.001)***		
International concordance			
	Contemporaneous	SA lags 2Q	SA lags 1Y
USA GDP	0.022 (0.871)	0.067 (0.6)	0.023 (0.872)
EMU GDP	0.054 (0.694)	-0.083 (0.497)	-0178 (0.186)

P-value are in brackets for the significance test with Newey-West standard errors (estimated with 5 lags)
* Significant at 10%
** Significant at 5%
*** Significant at 1%

Table 9: Concordance of various policy measures

Magnitude	Concordance with South African business cycle		
Monetary policy			
	Contemporaneous	Leading by 4 quarters[a]	Leading by 6 quarters[b]
Nominal interest rate	0.205 (0.157)	-0.342 (0.012)**	-0.4(0.001)***
Ex ante real interest rate (since 1977)	-0.09 (0.576)	0.028 (0.858)	-0112 (0.438)
Ex ante real interest rate (since 1990)	-0.429 (0.035)**	0.405 (0.022)**	0.227 (0.091)*
Fiscal policy			
Stance of fiscal policy	-0.21 (0.144)	-0.232 (0.049)**	-0.25 (0.04)**

a: the policy cycle leading the growth cycle by 4 quarters
b: the policy cycle leading the growth cycle by 6 quarters
P-value are in brackets for the significance test with Newey-West standard errors (estimated with 5 lags)
* Significant at 10%

Figure 1: Comparison of the SARB and BBQ cycles

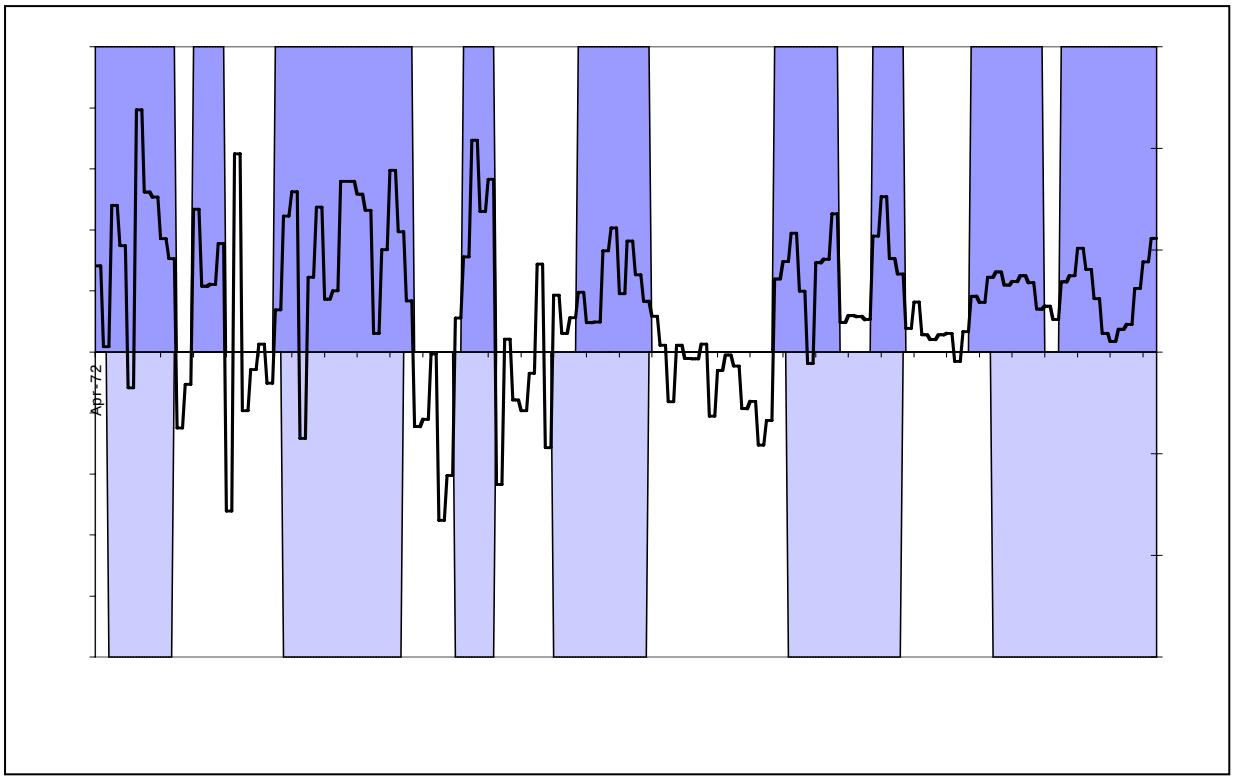

Figure 2: Comparing different definitions of the real interest rate

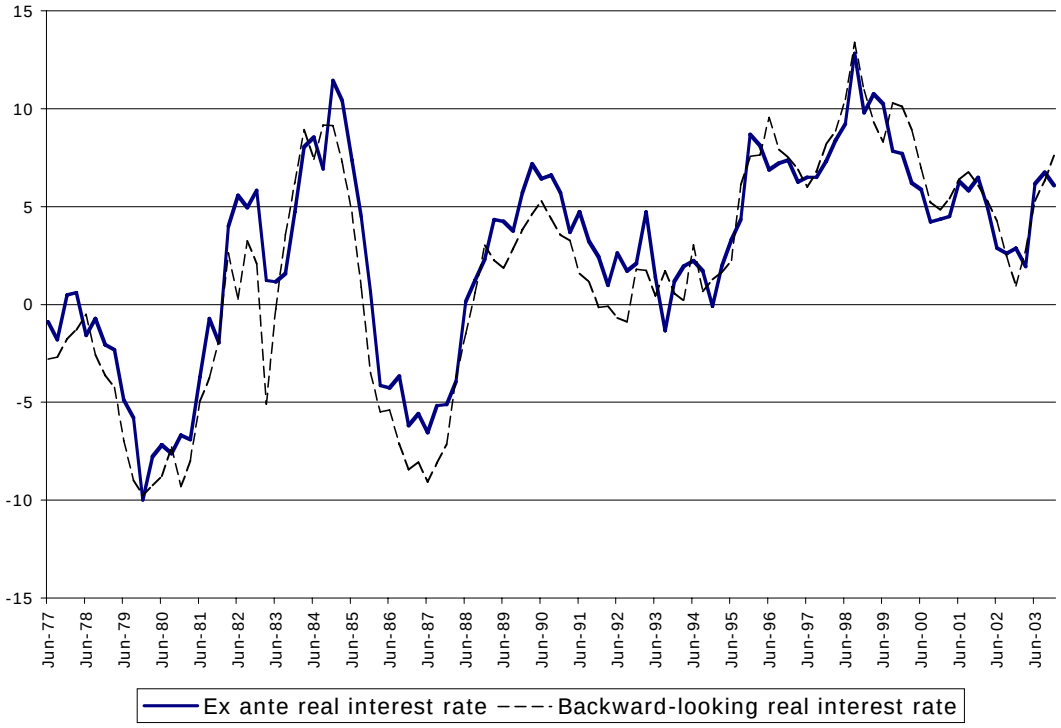

Figure 3: Periods of stabilising forward-looking real interest rates