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ABSTRACT

Linkages between the financial and real sectors of the economy have been studied extensively over the past twenty years to enhance business cycle forecasting on the one hand and improve portfolio allocation on the other. The broad aim of the paper is to investigate the relationship between cycles in the real economy and cycles in several financial variables from the South African money, bond and stock markets for the period from 1986 onwards. The paper will aim to describe the properties of cycles in such financial variables, where cycles were derived using a dating algorithm similar to that used to determine business cycle turning points. This method is consistent with the Burns and Mitchell tradition of business cycle analysis, but in contrast with the dominant approach in academic research, i.e. deviation cycles relying on time-series de-trending. Consequently, the paper will attempt to relate phases in the cycles of financial variables with business cycle phases to establish which variables satisfy preliminary requirements for leading indicators of the business cycle. The paper will consider both classical cycles as well as cycles in the growth rate of the different variables and include international variables, due to the potential importance of international developments for financial markets in an open economy.

JEL Classification: E30, E32, E37, E44, E47

THE PROPERTIES OF CYCLES IN SOUTH AFRICAN FINANCIAL VARIABLES AND THEIR RELATION TO THE BUSINESS CYCLE

Willem H. Boshoff*

Abstract
The paper describes cyclicality in a range of local and international financial variables and their relation to cyclical behaviour in the South African real economy. Cycles are derived using a dating algorithm similar to that used to determine business cycle turning points and falls within the Burns-Mitchell tradition of business cycle analysis. Co-movement between phases in financial variables and similar phases in the business cycle are described using the concordance statistic, instead of the correlation statistic (which requires stationarity). This acts as a preliminary step in identifying financial variables that can act as leading indicators of economic activity.

J.E.L. Classification: E30, E32, E37, E44, E47
Keywords: business fluctuations, cycles, financial markets and the macro-economy, forecasting

1. INTRODUCTION

Linkages between the financial and real sectors of the economy have been studied extensively over the past twenty years to enhance business cycle forecasting on the one hand and to improve portfolio allocation on the other. This paper contributes to this literature by analysing cyclicality in financial markets and its relation to the cyclical behaviour of the South African real economy. Turning points are identified for a range of local and international financial variables and are used to demarcate expansion and contraction phases in these variables. The paper attempts to describe the duration- and amplitude-related features of these phases using summary statistics. Thereafter, the co-movement between the phases in financial variables and similar expansion and contraction phases in the business cycle are described in order to identify financial variables that can act as leading indicators of economic activity. The concordance statistic (instead of the traditional correlation statistic) is used, as it does not require adjustment for non-stationary variables.

The descriptive study of cycle phases (using amplitude and duration measures) is a backward-looking method to establish stylised facts – allowing comparison of current cycle phases with features of historical cycles (see Bry and Boschan, 1971: 65-78). The cycle phases of South African financial variables have not been investigated in this manner – reflecting limited international studies on the properties of cycle phases in financial variables. Pagan and Sossounov (2003), a notable exception, describe bull and bear phases in stock markets of industrialised nations, while Edwards et al (2003) perform similar analyses for selected emerging markets.

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Leading indicator studies, on the other hand, comprise a much larger piece of business cycle literature. Originally proposed by Burns and Mitchell in 1938 (see Del Negro, 2001), leading indicators are now used by most central banks, including South Africa (see Van der Walt, 1984). Moolman (2003) and Moolman and Jordaan (2005) are recent South African studies concerned with assessing the suitability of several macroeconomic variables (including selected financial variables) in predicting turning points in the real economy and the stock market respectively. This paper attempts to identify suitable financial predictor variables that may serve as a basis for future research on formal business cycle regime prediction. This may involve univariate and multivariate limited dependent variable models (e.g. logit and probit models) (see Moolman and Jordaan, 2005). Many of the above models involve a regime-switching approach in light of the growing evidence on non-linear relationships between financial and real variables (Hamilton, 1989; Chauvet and Hamilton, 2005).

An investigation of the descriptive statistics of financial cycle phases as well as their co-movement with cycles in the real economy requires a clear concept of the term "cycle". The wide variety of cycle definitions as well as inconsistency in applying a particular definition has led to dubious conclusions in the literature (see Harding and Pagan, 2005 and Canova, 1998). This has resulted in a divergence between how academic economists and market practitioners view cyclicality in economic variables (Harding and Pagan, 2001: 2). The next section addresses this crucial issue.

2. CLARIFYING THE "CYCLE" CONCEPT

The conceptual framework of Harding and Pagan (e.g. 2001 and 2005) helps to address some of the definitional problems mentioned by distinguishing between classical, deviation and growth rate cycles. A classical cycle investigation entails an analysis of cycles in the levels of the relevant variables and is the type of cycle proposed by the pioneers of modern business cycle analysis – Burns and Mitchell (1946). The method, though, lost ground to so-called deviation cycles as critics claimed that the output from a turning point analysis of classical cycles did not have a sound statistical basis (see Blanchard & Fisher, 1989). The classical cycle concept, though, has regained importance in literature over the past few years – primarily through the work of Harding and Pagan (e.g. 2001, 2002 and 2005).

A further advantage of the classical cycle lies in its simplicity – it does not entail any data transformation or subsequent loss of information. The problem with transforming time series is illuminated by considering the deviation cycle concept, which has dominated cycle research over the past two decades. Deviation cycle analysis attempts to "de-trend" time series by removing a so-called permanent component. Harding and Pagan (2004), however, highlight the non-uniqueness of permanent components. For example, they argue that particular unit root series may be decomposed non-uniquely into another unit root series plus a stationary process (Harding and Pagan, 2004: 7)[1]. Moreover, Harding and Pagan show that turning points in deviation cycles may, in some cases, be identical to turning points in classical cycles. This situation could arise when censoring rules regarding amplitude are applied to deviation cycle data so as to remove minor cycles (Harding and Pagan, 2004: 8).

While the arguments in favour of classical cycles are strong, Artis et al (2005) argue that declines in, for example, the absolute level of economic activity may be rather extraordinary events. This argument also applies to certain financial variables (such as monetary aggregates) and indicates that a growth rate cycle investigation may be worthwhile. Growth rate cycles entail alternative periods of accelerating and decelerating growth (Osborn et al, 2005: 62). It should be noted that growth rates are essentially filters in which previous values of the original series is implicitly taken as the permanent component. Therefore, although growth rates do not escape the critique of Harding and Pagan (2004) entirely, this paper will entertain an agnostic approach by augmenting the classical cycle viewpoint with a growth rate cycle analysis where applicable. Growth rates in interest rate series (including yields and spreads) are not considered given their stationary (I(0)) behaviour – this corresponds with the approach by Osborn et al (2005) and Andreou et al (2000).

Following a decision on the type of cycle, the method used to describe the cycle becomes important. The Harding-Pagan taxonomy (2005) identifies several methods, including models assuming sinusoidal periodicity. The bulk of attention, however, is committed to turning point cycles where cycles are identified by reference to peaks and troughs in the particular series – as originally proposed by Burns and Mitchell (1946). The computerised version of the procedure is still in use at the National Bureau of Economic Research (NBER) and is formally described in Bry and Boschan (1971). According to Mohr (2000: 69), the South African Reserve Bank also employs the Burns-Mitchell framework.

The Burns-Mitchell method is a non-parametric method of turning point analysis. Parametric techniques, however, have dominated the literature over the past years – particularly since the development of the Markov-switching method (see Hamilton, 1989). While parametric models are important in forecasting applications, they may add unnecessary complexity when study goals are restricted to dating and describing cycles. Pagan (2004: 22) questions their transparency, pointing to the absence of clear rules when compared with the calculus rules of the non-parametric method (see the next section). In addition, turning points identified by Markov-switching models are sample and model dependent. The model may be adapted to find in-sample turning points that are identical to, for example, official turning points and may produce different turning points for different specifications.

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[1] Consider a series such as $\Delta y_t = e_t + \alpha e_{t-1}$. In this case, the permanent component produced by the Beveridge-Nelson decomposition is $\Delta y_t^p = (1+\alpha)e_t$. Therefore, the de-trended series will also be a function of e_t and, therefore, a function of the permanent component.

This paper investigates turning points in both the levels and the growth rates of financial time series using the non-parametric Bry-Boschan procedure. The next section outlines the technique.

3. NON-PARAMETRIC APPROACH TO IDENTIFY TURNING POINTS

The Bry-Boschan (1971) algorithm was recently applied to the South African and other emerging market business cycles by Du Plessis (2004 & 2005). In essence, the algorithm involves a calculus rule – to identify peaks and troughs in a series $\{ x_t \}$[2] – as well as a set of censoring rules to avoid spurious cycles.

The method identifies points in $\{ x_t \}$ which are either smaller or larger than a window of k surrounding values. That is, a peak is identified at time t if

$$\{ (x_{t-k}, \ldots, x_{t-1}) < x_t > (x_{t+1}, \ldots, x_{t+k}) \} \qquad (3.1)$$

and a trough at time t if

$$\{ (x_{t-k}, \ldots, x_{t-1}) > x_t < (x_{t+1}, \ldots, x_{t+k}) \} \qquad (3.2)$$

The size of k is arbitrary, but Bry and Boschan (1971) suggest an optimal size of five or six for monthly data. Pagan and Sossounov (2002), however, propose $k = 8$ as the most appropriate for stock markets. In this paper the window width is taken as six. Using eight as window width for stock market series do not yield significantly different results for the stock market variables in the dataset.

Additional censoring rules are imposed to ensure that spurious cycles are not identified (Harding and Pagan, 2001). However, following Pagan and Sossounov (2002) as well as Edwards et al (2003), the censoring rules differ from the original Bry-Boschan censoring rules in two ways – both related to the volatile nature of financial time series. Firstly, this paper does not perform outlier-adjustment – as extreme movements in financial time series (as opposed to real economic activity variables) may not be uncommon. Outlier-adjustment essentially results in a loss of information, although it does have the advantage of removing data errors. Secondly, the censoring rule pertaining to the minimum length of a phase is overridden in cases of extreme movements (see (4) below).

The censoring rules are therefore:

(1) Turns within four months of the beginning/end of the series are eliminated.

(2) Peaks or troughs lying next to endpoints and higher or lower than such endpoints are ignored.

(3) Complete cycles with total duration shorter than fifteen months are eliminated.

(4) Phases shorter than six months are eliminated, except for excessive falls/rises (defined quantitatively in the empirical part of the paper) where a minimum phase length of four months applies.

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[2] Or $\{ \log x_t \}$, as the method is invariant to a log transformation (Harding and Pagan 2001).

4. DESCRIBING THE PROPERTIES OF CYCLES

The features of expansion and contraction phases in financial variables can be described using the turning point chronologies. The features may be described through horizontal (or duration-related) phase statistics and vertical (or amplitude-related) phase statistics. Most of these statistics (horizontal and vertical) describe the cycle phases, while some (e.g. the variability measures) gauge the representativeness of the former by considering the extent of their variability over consecutive expansions or contractions.

As a preliminary step to calculating descriptive statistics, a dummy variable, s_t, is defined taking the value unity if there is an expansion in the series at time *t* and 0 if the series is in a contraction (Edwards et al, 2003 and Pagan and Sossounov, 2002). To serve as input in the calculation of cycle statistics, the following ancillary statistics are defined:

(1) The total time spent in an expansion is $\sum_{t=1}^{T} s_t$ and total time spent in a contraction is $\sum_{t=1}^{T} s_t$ where $b_t = 1 - s_t$.

(2) The number of peaks (or expansions), i.e. the number of trough-to-peak movements, is given by $NTP = \sum_{t=1}^{T-1} (1 - s_{t+1}) s_t$ – since the series $(1 - s_{t+1}) s_t$ equals unity in the case of a peak at time *t,* i.e. when $s_t = 1$, $s_{t+1} = 0$ (Harding and Pagan 2001). Similarly, the number of troughs (or contractions), i.e. the number of peak-to-trough movements, is given by $NPT = \sum_{t=1}^{T-1} (1 - b_{t+1}) b_t$.

These statistics are now used to estimate horizontal statistics, of which duration (*D*) is the most important. Note that the population value of *D* for a particular phase is unknown and must be estimated by calculating the sample average duration ($\hat{D}$), such that the average duration for an expansion phase is:

$$\hat{D}^{\text{expansion}} = NTP^{-1} \sum_{t=1}^{T} s_t \qquad (4.1.1)$$

Several additional duration characteristics are reported, including maximum and minimum duration, the proportion of time spent in either phase as well as the average duration of an expansion relative to a preceding contraction (Du Plessis, 2004: 27). Similar statistics for contraction phases are calculated by replacing *NTP* with *NPT* and s_t with b_t (this applies to both horizontal and vertical statistics).

The horizontal characteristics are then supplemented by vertical statistics to provide a two-dimensional description of cycle phases. The amplitude (*A*) and steepness (Ω) measures for cycle phases are again estimated by calculating the sample average amplitude ($\hat{A}$) and steepness ($\hat{\Omega}$) for each phase:

$$\hat{A}^{\text{expansion}} = NTP^{-1}\sum_{t=1}^{T} s_t \Delta(x_t) \qquad (4.1.2)$$

$$\hat{\Omega}^{\text{expansion}} = \frac{\hat{A}^{\text{expansion}}}{\hat{D}^{\text{expansion}}} \qquad (4.1.3)$$

Another vertical characteristic is the volatility or "noisiness" measure (*V*) proposed by Edwards et al (2003). The sample volatility ($\hat{V}$) of an expansion phase is defined as the average magnitude of the monthly change (with a similar definition applying to a contraction phase):

$$\hat{V}_{\text{expansion}} = \frac{1}{\sum_{t=1}^{T} s_t}\sum_{t=1}^{T} s_t \left|\Delta x_t\right| \qquad (4.1.4)$$

As it is based on absolute values, it prevents occasional negative (positive) movements from being hidden by the generally positive (negative) movements in the series. It is therefore comparable to the steepness measure – if the value is much larger than the absolute value of steepness the series may be considered relatively noisy. The proportion of phases with amplitude higher than a particular threshold (see the empirical part of the paper) is also reported.

A final set of statistics is the variability measure (Γ) for both duration and amplitude. These statistics assess the similarity of consecutive phase duration and amplitude values relative to the average values and highlights information that may be lost during the averaging process. The sample variability ($\hat{\Gamma}$) of duration is closely related to the coefficient of variation and is unitless (Pagan 2004). This is useful for a comparison of the dispersion of values in two series. For an expansionary phase in duration it is estimated as:

$$\hat{\Gamma}_{D}^{\text{expansion}} = \frac{\sqrt{NTP^{-1}\sum_{i=1}^{NTP}(\hat{D}_i^{\text{expansion}} - \overline{D}^{\text{expansion}})^2}}{NTP^{-1}\sum_{i=1}^{NTP}\hat{D}_i^{\text{expansion}}} \qquad (4.1.5)$$

Similar statistics can be calculated for contraction phases and for amplitude (instead of duration).

5. LEADING INDICATOR PROPERTIES OF FINANCIAL VARIABLES: PRELIMINARY EVIDENCE

The phase statistics in the previous section are calculated for expansion and contraction phases separately. Past studies have revealed that these phases may bear close resemblance to expansions and contractions in cycles of real economic activity. This paper attempts a re-examination of the leading indicator properties of South African financial variables.

Traditionally, leading indicator evaluation has focused on five criteria – of which two are the most important (see Van der Walt, 1984). Firstly, leading indicator studies aim to investigate the general co-movement between the potential leading series and the series representing real economic activity. Secondly, consistency in the timing of turning points in the two series is investigated. This paper considers only the first criterion and should be considered part of a larger research effort to identify suitable leading indicators among financial variables. Future research should assess, *inter alia*, the variance in the time interval between the turning points in the potential leading indicator series and the real activity series.

Literature relies primarily on cross-correlation statistics to assess co-movement between two series (see for example Andreou et al, 2000), but these statistics require stationary time series. The time series properties of first differences of a series, however, differ from the properties of series in levels. Specifically, Bry and Boschan (1971: 13) illustrate the difference in the duration of cycle phases for series in first differences versus levels. Consequently, statistically significant correlation of a differenced series with some other stationary variable does not imply a statistically significant correlation between the series in levels and the other variable. This paper attempts an investigation of leading indicator properties using the concordance statistic, which does not require stationary time series.

The stationary requirement for correlation calculations is not the only deficiency: high correlation may be the result of a single shock common to two series that are otherwise independent (McDermott and Scott, 2000: 18). The concordance statistic, on the other hand, does not suffer from sudden jumps in series as it is based on the constructed state variable series $\{s_t\}$ instead of the actual series $\{x_t\}$.

Formally, co-movement, or the degree of synchronisation of two series, is assessed by considering what proportion of time the two series are in the same phase simultaneously. Statistically, this amounts to testing whether $I = \Pr(S_{xt} = S_{yt})$ is close to 1, where S_{xt} = 1 identifies an expansion in financial series $\{x_t\}$ and S_{yt} = 1 identifies a business cycle upswing at time *t*. For a particular sample, the equivalent of $\Pr(S_{xt} = S_{yt})$ is the so-called concordance index ($\hat{I}$) (Harding and Pagan 2003):

$$\hat{I} = \frac{1}{T}\{\#(s_{xt} = 1, s_{yt} = 1) + \#(s_{xt} = 0, s_{yt} = 0)\} \qquad (5.1)$$

$$\hat{I} = \frac{1}{T}\{\sum_{t=1}^{T} s_{xt}s_{yt} + \sum_{t=1}^{T}(1 - s_{xt})(1 - s_{yt})\} \qquad (5.2)$$

The index originally ranges from zero (perfect non-alignment) to one (perfect alignment), with 0.5 indicating independence. However, the concordance index can be re-scaled to lie in the range [-1;1] – thus enhancing its comparability with conventional correlation statistics. To consider lagged co-movement, the series $\{x_t\}$ is replaced with $\{x_{t-m}\}$, an m-period lagged version of $\{x_t\}$.

The sample statistic $\hat{I}$ can now be used to test the statistical significance of the population statistic *I*. However, high or low values of $\hat{I}$ relative to 0.5 cannot be interpreted *a priori* as statistically significant. To see this, Harding and Pagan (2003: 11) propose rewriting (6.1) as:

$$\hat{I} = 1 + 2\hat{\rho}_S\hat{\sigma}_{Sx}\hat{\sigma}_{Sy} + 2\hat{\mu}_{Sx}\hat{\mu}_{Sy} - \hat{\mu}_{Sx} - \hat{\mu}_{Sy} \qquad (5.3)$$

where $\hat{\rho}_S$ estimated correlation coefficient between states S_{xt} and S_{yt}

$\hat{\mu}_{Sx}$ and $\hat{\mu}_{Sy}$ estimated mean of S_{xt} and S_{yt} respectively

$\hat{\sigma}_{Sx}$ and $\hat{\sigma}_{Sy}$ estimated standard deviation of S_{xt} and S_{yt} respectively

If $\hat{\rho}_S = 0$, that is, if the constructed state variables S_{xt} and S_{yt} are uncorrelated, $E(\hat{I})$ can only be 0.5 if $\hat{\mu}_{Sx} = \hat{\mu}_{Sy} = 0$. If this is not the case, high or low values of $\hat{I}$ might be misleading. To overcome this problem, Artis et al (2004) suggest that the mean-corrected values of $\hat{I}$ should be presented. A test statistic can then be constructed from the mean-corrected $\hat{I}$ by dividing it with its standard error under the null hypothesis of independence between S_{xt} and S_{yt}. Unfortunately, this process requires substantial calculation effort. Harding and Pagan (2003), though, propose an alternative. They show that $\hat{I}$ and $\hat{\rho}_S$ in (5.4) are related monotonically such that a statistical test for the significance of $\hat{\rho}_S$ can be used to assess the significance of $\hat{I}$. To assess the significance of $\hat{\rho}_S$, consider the following linear regression:

$$\hat{\sigma}_{Sy}^{-1}S_{yt} = \eta + \hat{\rho}_S\hat{\sigma}_{Sx}^{-1}S_{xt} + \varepsilon_t \qquad (5.4)$$

with η a constant

ε_t an independent and identically distributed error term

However, under the null hypothesis that $\hat{\rho}_S = 0$, the error term ε_t inherits the serial correlation properties of S_{yt} – which risks conditional heteroscedasticity (Harding and Pagan, 2003). This may result in incorrect inferences regarding the significance of $\hat{\rho}_S$. To account for this problem, the OLS estimates are obtained using heteroscedasticity and autocorrelation consistent (HAC) standard errors[3]. The method proposed by Newey and West (1987) is used to obtain the HAC estimates using Bartlett weights and an automatic bandwidth selection procedure. The robust *t*-ratios are then evaluated to determine the statistical significance of $\hat{I}$. The paper now turns to the empirical part.

6. DATA AND VARIABLES

The statistical properties of financial variables are investigated using monthly data, while quarterly real GDP is used as a measure of real economic activity. The frequency mismatch between GDP and the financial variables inevitably results in a loss of information. Hence, monthly industrial production data is also analysed, though this measure does not sufficiently reflect the structure of the South African economy.

As discussed, growth rate cycles for selected variables will also be investigated. Osborn et al (2005: 65) argue that both three- and twelve-month growth rates should be considered in order to capture shorter- and longer-term movements in variables. However, the dataset contains unsmoothed series that may yield noisy short-term growth rates. Moreover, empirical results tend to be alike for three-month and twelve-month rates. Consequently, this paper restricts attention to a twelve-month growth rate based on differences in the levels or logarithmic levels of the series.

This study, focusing on South African financial time series, follows the variables proposed by Sarantis and Lin (1999) and Andreou et al (2000). Variables include series from the domestic bond, stock and foreign exchange markets, as well as domestic monetary variables and a few series from international financial markets. The appendix contains a full specification of variables and data sources.

In the monetary sector, real M1 and M3 monetary aggregates are considered; the M2 money measure is excluded given its close movement with the M3 measure. From the bond market, short-term and long-term interest rates as well as the term structure of interest rates (i.e. the yield curve) are investigated. The yield curve is calculated as the difference between long- and short-term interest rates (Sarantis and Lin, 1999: 92; Chauvet and Potter, 2005: 77). Alternatively, the yield curve can be calculated on a relative basis as the quotient of the long-short interest rate difference and the short-term rate. As results are similar, all spreads are handled on an absolute, rather than relative, basis.

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[3] The R statistical language is used to perform the regressions (R Foundation for Statistical Computing, 2005).

Stock market variables include share price indices, dividend yields, price-to-earnings ratios as well as reverse yield gaps. The reverse yield gap is defined as the difference between the dividend yield and long-term interest rates (Sarantis and Lin, 1999: 92) to account for the impact of inflation on returns in the bond market relative to the stock market. Also, the real reverse yield gap is calculated as the difference between the dividend yield and *real* long-term interest rates.

From the foreign currency market, this paper investigates both the rand-dollar exchange rate and the effective exchange rate of the rand. From the international financial markets, selected US stock market indices, interest rates and interest rate differentials are analysed. Representative indices for emerging stock and bond markets are also considered.

The sample period for the series normally runs from 1986 to 2004, although sample periods may start as recently as 1995 for a few variables. The choice of the sample period is determined by the move from a liquid asset ratio-based monetary policy regime to a more market-based regime around 1985 (Aron and Muellbauer, 2002). Following Andreou et al (2000: 399). Series are seasonally adjusted where needed.

The following sections report the empirical observations separately in terms of descriptive statistics and the concordance measures.

7. PROPERTIES OF CYCLES IN FINANCIAL VARIABLES

Interpretation of the stylised facts presented here requires a lucid understanding of the unique macroeconomic context within which any particular cycle arises. The economist should be forewarned not to confound the extent of regularity and recurrence in economic series with the idea that consecutive cycles are quite alike. Such cases may well exist, but it is safe to heed the warning of Burns (1969: 24): "It is also well to keep in mind, first, that the generalizations emphasize the repetitive features of the economic changes that takes place during business cycles; second, that they merely express strong tendencies toward repetition – not invariant rules of behaviour." The focus is not so much on the quantitative values *per se* as it is on creating descriptive measures that are readily comparable across series.

Table 1: Summary of classical cycle features for contraction phases relative to expansion phases (1)

Financial variable	Horizontal features				Vertical features			
	1 Average Contraction Duration vs Expansions	*2* Supported by other stats?	*3* Variability of Successive Contraction Durations	*4* Variability of Successive Expansion Durations	*5* Average Contraction Amplitude vs Expansions	*6* Average Contraction Steepness Vs Expansions	*7* Variability of Successive Contraction Amplitudes	*8* Variability of Successive Expansion Amplitudes
Real M1	Shorter	Yes	0.28	0.48	Lower	Steeper	0.25	0.53
Real M3	Shorter	Yes	0.94	0.60	Lower	Steeper	0.65	0.38
JSE All Share Index	Shorter	Yes	0.37	0.51	Lower	Steeper	0.57	0.37

JSE Fin and Ind Index	Shorter	Yes	0.57	0.48	Lower	Steeper	0.64	0.41
JSE Resources Index	Shorter	Yes	0.62	0.48	Lower	Steeper	0.30	0.56
MSCI Emerging Market	Shorter	Yes	0.58	0.36	Lower	Steeper	0.42	0.51
JSE ALSI Divid Yield	Slightly longer	Yes	0.52	0.55	Lower	Similar	0.35	0.47
JSE ALSI P:E Ratio	Similar	Uncertain	0.98	0.71	Slightly lower	Similar	0.46	0.51
Real Effective Rand #	Longer	Yes	0.37	0.64	Higher	Steeper	0.45	0.25
Real Rand-Dollar #	Shorter	Yes	0.34	0.37	Lower	Shallower	0.19	0.56

Note that the features of the effective rand and bilateral rand-dollar exchange rates are quite similar as depreciations are characterised as *contraction* phases in the effective exchange rate and as *expansion* phases in bilateral exchange rates (such as the R/$).

Table 2: Summary of classical cycle features for contraction phases relative to expansion phases (2)

Financial variable	Horizontal features				Vertical features			
	1 Average Contraction Duration vs Expansions	*2* Supported by other stats?	*3* Variability of Successive Contraction Durations	*4* Variability of Successive Expansion Durations	*5* Average Contraction Amplitude vs Expansions	*6* Average Contraction Steepness Vs Expansions	*7* Variability of Successive Contraction Amplitudes	*8* Variability of Successive Expansion Amplitudes
3-month Treasury Bill yield	Slightly shorter	Yes	0.82	0.57	Higher	Steeper	0.60	0.56
12-month NCD interest rate	Longer	Yes	0.65	0.71	Higher	Shallower	0.58	0.54
10-year govt bond yield	Longer	Yes	0.57	0.83	Higher	Shallower	0.48	0.48
Real 3-m T-Bill yield	Longer	Yes	0.73	0.52	Lower	Shallower	0.49	0.51
Real 12-m NCD interest rate	Shorter	Yes	0.56	0.44	Lower	Similar	0.39	0.54
Real 10-year govt bond yld	Similar	Yes	0.37	0.63	Lower	Shallower	0.47	0.48
Yield curve	Longer	Uncertain	0.68	0.59	Higher	Similar	0.50	0.38
Reverse yield gap	Longer	Uncertain	0.54	0.69	Higher	Similar	0.37	0.40
Real reverse yield gap	Shorter	Yes	0.29	0.52	Lower	Steeper	0.44	0.44
Foreign int rate differential	Shorter	Yes	0.29	0.58	Lower	Similar	0.55	0.24
US Federal Funds rate	Longer	Uncertain	0.53	0.25	Higher	Similar	0.76	0.58
US 10-year govt bond yield	Longer	Yes	0.38	0.22	Higher	Shallower	0.26	0.34

Table 3: Summary of growth rate cycle features for contraction phases relative to expansion phases

Financial variable	Horizontal features				Vertical features			
	Average Contraction Duration vs	Supported by other stats?	Variability of Successive Contraction	Variability of Successive Expansion	Average Contraction Amplitude vs	Average Contraction Steepness Vs	Variability of Successive Contraction	Variability of Successive Expansion

	Expansions		Durations	Durations	Expansions	Expansions	Amplitudes	Amplitudes
Real M1	Shorter	Yes	0.47	0.45	Lower	Similar	0.26	0.35
Real M3	Slightly shorter	Uncertain	0.54	0.44	Lower	Similar	0.13	0.42
JSE All Share Index	Longer	Uncertain	0.44	0.33	Lower	Shallower	0.27	0.34
JSE Fin and Ind Index	Longer	Yes	0.34	0.25	Lower	Shallower	0.24	0.41
JSE Resources Index	Similar	Uncertain	0.25	0.37	Higher	Steeper	0.22	0.34
S&P 500 Share Index	Similar	No	0.59	0.49	Lower	Similar	0.55	0.53
MSCI Emerging Share	Longer	Yes	0.25	0.27	Similar	Shallower	0.30	0.37
JP Morgan Emerging Bond	Similar	Uncertain	0.61	0.42	Lower	Similar	0.53	0.61
Real Effective Rand	Longer	Uncertain	0.55	0.31	Lower	Shallower	0.53	0.70
Real Rand-Dollar	Shorter	Uncertain	0.38	0.33	Higher	Steeper	0.60	0.31
Nominal Rand-Dollar	Shorter	Uncertain	0.41	0.33	Higher	Steeper	0.58	0.31

Tables 1 and 2 describe the salient features of classical cycles and Table 3 of growth rate cycles in South African financial variables. In effect, the tables offer an explicitly narrow summary of a much larger body of individual cycle research too voluminous to consider in detail[4]. The tables report whether contractions have lower, similar, or higher average duration (column 1), average amplitude (column 5) and steepness (column 6) compared to expansions. Column 2 shows whether the duration conclusions in column 1 are mainly supported by two other statistics, namely:

(i) The average length of an expansion relative to a preceding contraction phase.
(ii) The proportion of time spent in either phase.

Variability measures for duration (columns 3 and 4) and amplitude (columns 7 and 8) are also reported to illustrate the extent to which contraction and expansion phases are similar to the average value.

Table 4: Duration and amplitude of contractions relative to expansions in classical cycles

CONTRACTION AMPLITUDE VS EXPANSIONS	**CONTRACTION DURATION VS EXPANSIONS**		
	Shorter	**Similar**	**Longer**
Lower	Real 12-m NCD rate Real 3-m TB yield Foreign int rate differential Real M1 Real M3 JSE All Share Index	Real 10-yr govt bond yield JSE ALSI dividend yield	

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[4] A set of tables for individual series is available from the author upon request.

	JSE Fin and Industrial Index JSE Resources Index MSCI Emerging Market Real Rand-Dollar		
Similar		JSE ALSI P:E Ratio	
Higher		3-month Treasury Bill Yield	12-m NCD rate 10-yr govt bond yield Yield curve Reverse yield gap US Federal Funds rate US 10-yr govt bond yield Real effective rand

Table 5: Duration and steepness of contractions relative to expansions in classical cycles

CONTRACTION STEEPNESS VS EXPANSIONS	**CONTRACTION DURATION VS EXPANSIONS**		
	Shorter	**Similar**	**Longer**
Lower	Real Rand-Dollar Real 3-m Treasury Bill yield	Real 10-year govt bond yield	12-m NCD interest rate 10-year govt bond yield US 10-year govt bond yield
Similar	Real 12-m NCD interest rate Foreign int rate differential	JSE ALSI Dividend Yield JSE ALSI P:E Ratio	Yield Curve Reverse Yield Gap US Federal Funds rate
Higher	Real M1 Real M3 JSE All Share Index JSE Fin and Industrial Index JSE Resources Index MSCI Emerging Market	3-m Treasury Bill Yield	Real Effective Rand

Table 6: Duration and amplitude of contractions relative to expansions in growth rate cycles

CONTRACTION AMPLITUDE VS EXPANSIONS	**CONTRACTION DURATION VS EXPANSIONS**		
	Shorter	**Similar**	**Longer**
Lower	Real M1	Real M3 S&P 500 Share Index JP Morgan Emerging Bond	JSE All Share Index JSE Fin and Industrial Index Real Effective Rand
Similar			MSCI Emerging Share
Higher	Real Rand-Dollar Nominal Rand-Dollar	JSE Resources Index	

Table 7: Duration and steepness of contractions relative to expansions in growth rate cycles

CONTRACTION STEEPNESS VS EXPANSIONS	CONTRACTION DURATION VS EXPANSIONS		
	Shorter	**Similar**	**Longer**
Lower			JSE All Share Index JSE Fin and Industrial Index MSCI Emerging Share Real Effective Rand
Similar	Real M1	Real M3 S&P 500 Share Index JP Morgan Emerging Bond	
Higher	Real Rand-Dollar Nominal Rand-Dollar	JSE Resources Index	

Tables 4 and 5 clarify the relationships between duration, amplitude and steepness of classical cycles as implied in Tables 1 and 2. The exposition in Table 4 illustrates duration-amplitude relationships. The focus is on the total effect of a particular phase movement (as measured by amplitude), rather than on the intensity of such movement (as measured by steepness). Amplitude may be duration-biased, i.e. longer phases may have higher amplitude, perhaps because longer duration allows more time for amplitude to accumulate. Table 5 accounts for this problem by summarising the duration-steepness relationships implied by Tables 1 and 2. Tables 6 and 7 work out similar illustrations for growth rate cycles. The following discussion highlights selected conclusions, many of which are not controversial:

(a) Depreciation phases appear to dominate cycles in exchange rates. Such phases last longer, have greater effect (higher amplitude) and are more intense (steeper) relative to periods of appreciation. Initially, growth rate analysis appears to contradict this position. However, after removal of the final turning point capturing the recent appreciation phase, the growth rate cycle suggest interpretations similar to the classical cycle (which does not share such a turning point).

(b) Bear market phases in the local All Share as well as the Financial and Industrial Share price indices are shorter and steeper relative to bull market phases, but their overall effects (i.e. their amplitude) are smaller. These align with the duration findings for emerging markets such as Brazil and Chile (see Edwards et al, 2003). Furthermore, the growth rate cycle suggests that growth deceleration phases last longer and are less intensive. Hence, slowdown in stock market performance (excluding Resources) is more subtle and prolonged when considered in proportional, rather than absolute, terms.

(c) Phases in the classical cycle of the All Share dividend yield and price-earnings ratio are alike in duration, amplitude and steepness and exemplify the stability of stock market yields relative to share price indices.

(d) Historical price instability has had adverse consequences for the cyclical features of interest rates in South Africa. Cycles in longer-term nominal interest rates on twelve-month and ten-year maturity assets exhibit expansions with shorter duration and lower amplitude vis-à-vis contraction phases. Real rates, accounting for inflationary expectations, do not mimic this. Expansions in longer-term real interest rate cycles have longer duration, higher amplitude and higher steepness when compared to contraction phases. Short-term rates share similar characteristics, although there is not consensus on steepness in the different phases.

8. THE RELATIONSHIP OF CYCLES IN FINANCIAL VARIABLES AND CYCLES IN REAL ACTIVITY

The cyclical features of financial variables highlighted above may bear close resemblance to cycles in real economic activity. Such financial variables may therefore be useful as leading indicators of economic activity. This section investigates the leading indicator properties of financial variables through the mean-corrected concordance statistic of cycles in financial variables with the classical and growth rate cycles of GDP. The concordance measures of cycles in financial variables with the classical and growth rate cycle of industrial production offer complementary evidence.

All variables are investigated in a group format by evaluating the *t*-ratio (from the regression as discussed) to determine the statistical significance of the concordance statistic. It is important to note that, for a particular variable, either all or no lags are statistically significant. This is due to the close similarity between sample periods for tests of different lags. For example, the test for a lag of one takes the sample period (of the financial variable) applicable to the test of a zero lag and adjusts the period by shifting it one month forward.

After statistical significance has been established, the lag range is identified for which the absolute value of the concordance statistic is maximised. High concordance with opposite signs at both high and low lags should be interpreted with caution. The high lag statistic may be measuring concordance with the next phase of the business cycle. In such cases, the lower range is given preference where the average phase durations in the real series are shorter than the higher lag mentioned above. The following presents a short overview of which variables appear to be superior as leading indicators. The optimal lags are not discussed, but are summarised later on in this section.

It is now possible to construct tables consisting of all variables for which their classical cycles (Table 8) or growth rate cycles (Table 9) exhibit statistically significant co-movement with cycles in real economic activity. The table reports the monthly lag or lag range for which the particular co-movement is maximised for the particular sample.

Although more formal selection procedures exist to determine the exact lag, this may not be preferable (see the introduction).

Table 8: Statistically significant leading indicators (with indicator cycle in classical form) with optimal lag ranges in months (p-values for the null of zero concordance indicated in brackets)

Financial Variable Classical Cycle	GDP	Industrial Production	GDP	Industrial Production
	Classical Cycle	Classical Cycle	Growth rate Cycle	Growth rate Cycle
Real M1 monetary aggregate				[1 - 3] (0.241)
Real M3 monetary aggregate	[1 - 3] (0.138)	[1 - 3] (0.065)		
3 month Treasury Bill yield (nominal)	[1 - 3] (0.011)			
3 month Treasury Bill yield (real)	[1 - 3] (0.083)			[1 - 3] (0.203)
12 month NCD rate (nominal)	[1 - 3] (0.134)		[1 - 3] (0.157)	
10 year Government Bond yield (real)	[1 - 3] (0.162)			
Yield Curve	[9 - 12] (0.188)			
JSE Resources Index	[6 - 9] (0.228)	[6 - 9] (0.071)		
US Federal Funds Rate	[6 - 9] (0.147)	[1 - 3] (0.001)	[1 - 3] (0.004)	[1 - 3] (0.131)
US 10 yr Govt Bond yield		[1 - 3] (0.199)	[3 - 6] (0.069)	[3 - 6] (0.003)
MSCI Emerging Market Share Index		[3 - 5] (0.234)		

Table 9: Statistically significant leading indicators (with indicator cycle in twelve-month growth rate form) with optimal lag ranges in months (p-values for the null of zero concordance indicated in brackets)

Financial Variable Growth Rate Cycle	GDP	Industrial Production	GDP	Industrial Production
	Classical Cycle	Classical Cycle	Growth rate Cycle	Growth rate Cycle
Real M3 monetary aggregate		[3 - 5] (0.086)		
JP Morgan Emerging Market Bond Index			[1 - 3] (0.036)	
Real Effective Rand		[1 - 3] (0.165)		
Nominal Rand-Dollar Exchange Rate		[2 - 4] (0.161)		
Real Rand-Dollar Exchange Rate		[2 - 4] (0.081)		[1 - 3] (0.173)

This offers a useful summary for comparison with the variables used by the South African Reserve Bank in their leading composite indicator. In South Africa, the composite leading indicator contains, among others, the growth rate of real M1 money supply, the growth rate of a JSE share price index as well as an interest rate spread (Venter and Pretorius, 2004: 69). The use of the real M1 and JSE variables, though, are questionable in the light of the evidence from Tables 8 and 9.

Regarding monetary aggregates it is clear that real M3 performs better as leading indicator of classical cycles relative to real M1. This holds for both the levels (classical cycle) and growth rate of real M3. The M1 classical cycle exhibits significant co-movement only with growth rate cycles in industrial production. This does not agree with the Reserve Bank findings that M1 growth is related to the growth rate cycle in overall GDP. As far as the stock market is concerned, our evidence is even more contradictory. No growth rate in any of the local share price indices appear to be significant, while only the levels (i.e. classical cycles) in the Resources Index appear to exhibit significant co-movement with classical cycles in real activity. While concordance-style research is scant in the literature, these results mimic findings for the UK, Germany, France and Italy, but contrast with positive evidence for the US (Avouyi-Dovi and Matheron, 2005: 24). Our research supports the use of the yield curve as leading indicator at a longer horizon. Moolman (2004) also finds positive evidence for the predictive capacity of the yield curve), although interest rates, notably the nominal three-month Treasury bill yield, perform better over shorter leads.

The absence of any international financial variables from the composite leading indicator is a potential deficiency. The concordance statistics of classical cycles in US interest rates with cycles in South African economic activity are among the highest for all of the variables studied. Moreover, the growth rate in the JPM EMBI has significant concordance with growth rate cycles in South African GDP. However, bilateral R/$ exchange rates appear to be largely co-moving with industrial production cycles (rather than GDP). The real effective rand, though, exhibits statistically significant co-movement with the GDP growth cycle.

9. CONCLUSION

This paper attempts, firstly, to describe historical cycles in important local and international financial variables and, secondly, to analyse the co-movement between cycles in these variables and cycles in South African economic activity. The importance of the former does not rest solely on its relationship to business cycles, as cyclical analysis is also crucial to determining the risk profile of the South African economy.

The results concerning co-movement between cycles in financial variables and real activity are at variance with variables that the Reserve Bank prefers. While one should not place too much emphasis on a single study, such deviations do raise questions. Specifically, the absence of international financial market variables ignores the important role of international financial markets in the cyclical fluctuations of a small, open economy such as South Africa.

This study represents the first step in a larger effort to analyse the leading indicator properties of South African financial variables. Future research will be geared towards an analysis of the consistency in the lead times between turning points in financial variables and turning points in the real economy.

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APPENDIX: DATA AND SOURCES

Description	Source	Frequency	Dates
Real variables			
Industrial Production, seasonally adjusted	SARB	Monthly	01/86 – 12/04
Gross Domestic Product, seasonally adjusted	SARB	Quarterly	01/86 – 12/04
Consumer Price Index, seasonally adjusted	SARB	Monthly	01/86 – 12/04
Money market			
Money supply M1, seasonally adjusted	SARB	Monthly	01/86 – 12/04
Money supply M3, seasonally adjusted	SARB	Monthly	01/86 – 12/04
Bond market			
3 month Treasury Bill yield	SARB	Monthly	01/86 – 12/04
12 month Negotiable Certificate of Deposit interest rate	SARB	Monthly	01/86 – 12/04
Government Bonds long-term yield (10 years)	SARB	Monthly	01/86 – 12/04
Foreign exchange market			
Rand-Dollar Exchange Rate	SARB	Monthly	01/86 – 12/04
Rand Effective Exchange Rate	SARB	Monthly	01/90 – 12/04
Stock market			
JSE-FTSE All Share Index	MGBFA	Monthly	01/86 – 12/04
JSE-FTSE Financial and Industrial Index	MGBFA	Monthly	01/87 – 12/04
JSE-FTSE Resources Index	MGBFA	Monthly	01/86 – 12/04
JSE-FTSE All Share Index – dividend yield	MGBFA	Monthly	01/86 – 12/04
JSE-FTSE All Share Index – price-earnings ratio	MGBFA	Monthly	01/86 – 12/04
International variables			
S&P 500	MGBFA	Monthly	07/88 – 12/04
US Federal Funds Rate	MGBFA	Monthly	01/86 – 12/04
US Government Bonds long-term yield (10 years)	MGBFA	Monthly	01/86 – 12/04
MSCI Emerging Market Share Index	MSCI	Monthly	12/87 – 12/04
JP Morgan Emerging Market Bond Index	REUTERS	Monthly	12/90 – 12/04

Notes: SARB, South African Reserve Bank; MSCI, Morgan Stanley Capital International; MGBFA, McGregor-BFA database