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Abstract

The money supply can be broadly defined as consisting of currency and deposits. While currency forms but a small portion of the total money supply, it can be a crucial determinant of spending behaviour and subsequently economic activity. The ability of the money supply to predict an up- or downswing in economic activity, as measured by a positive or negative output gap, is evaluated over a sample period 1980 – 2012. Two models are estimated, one using only the currency component and a second using the total money supply (M3). It is found that the growth rate of real currency in circulation is reasonably accurate in predicting economic activity 6 months ahead, whereas the total money supply can predict economic activity up to 9 months ahead. It is concluded that currency in circulation can be a valuable additional source of information to policymakers and can complement other approaches of forecasting economic activity.

JEL codes: C25, E32, E37, E51

Keywords: business cycle, output gap, currency in circulation, probit

1 Introduction

The focus of this paper is to test a hypothesis that currency in circulation can be used to forecast economic activity in South Africa. The benefit of the existence of such a relationship would be that data on currency in circulation is readily available, offering an informational advantage of a number of months relative to traditional forecasting models and indicators. The rest of this paper is organised as follows: Section 2 surveys the current literature on business cycles and leading and coincident indicators, and how these indicators are used

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to model and predict turning points in the business cycle or economic activity. The connection between the business cycle and the output gap is also considered. Section 3 extends the literature review to the role of the money supply and cash or currency in stimulating economic activity and offers some preliminary data and graphical analyses in the South African context. Section 4 proposes a formal econometric approach to model the ability of the money supply and currency in circulation to predict the probability of an economic slowdown, the results of which are presented in section 5. Conclusions follow in section 6.

2 Literature review

The term "business cycle" was initially formulated by Burns and Mitchell in their seminal 1946 work. According to their definition, which is still widely used nearly 70 years later,

"Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organise their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals which merge into the expansion phase of the next cycle; the sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own" (1946: 1).

Their definition highlights three significant characteristics of the business cycle, namely duration, amplitude and scope (Venter 2005). Achuthan and Banerji (2004) have referred to these as "the three Ps", i.e. that aggregate economic activity must "change direction in a way that is pronounced, pervasive and persistent" (2004: 112). Their definition also implies that aggregate economic activity is the result or outcome of a number of different activities, and can therefore not simply be expressed as or encapsulated in one series. This has led to the development of the indicator approach (also known as the NBER approach, after the National Bureau of Economic Research where this approach was pioneered) in which a number of diverse, but generally highly cyclical, activities (or indicators) are evaluated to construct a chronology of reference turning points for the business cycle. This classical indicator approach to identifying cyclical turning points involves "analysing the clustering of turning points in a number of coincident indicators" (Venter 2010: 15) and a subsequent aggregation of these indicators into an overall turning point index[1]. The salient features of this approach are the high cyclical conformity or co-movement of the various indicators, which should all theoretically contribute to aggregate economic activity, as well as the fact that evidence from a number of independently compiled indicators are likely to be more reliable than evidence from any individual series (Zarnowitz 1992).

The classical indicator approach should be distinguished from the growth cycle definition of business cycles. Classical business cycles refer to "*absolute*

[1] Zarnowitz (1992, 2001) presents the arguments in favour of this multi-variable approach.

declines in aggregate economic activity followed by *absolute* increases in aggregate economic activity" (Venter 2005: 61), whereas growth cycles represent the "fluctuations around the long-term growth trend of aggregate economic activity" (*ibid.*). According to the classical approach, a downturn will be present when a number of indicators demonstrate a decline in levels. The growth cycle approach on the other hand is based on "the deviations in economic activity from trend" (Banerji and Hiris 2001: 334), and will indicate a downturn if these indicator series grow significantly below trend over a certain time period. This approach, however, suffers from the "endpoint" problem prevalent in many economic time series, where trend estimates can often be unstable towards the end of the time series, casting some doubt over the validity of the imposed trend. Zarnowitz and Ozyildirim (2001: 1) warn that "faulty trend estimates can cause significant errors", making this approach ill-suited for real-time trend estimation.

There is thus a further distinction between the growth cycle and the growth *rate* cycle, which was more recently introduced by Layton and Moore (1989). The growth rate cycle evaluates the latest growth rates relative to the preceding average growth rates in a number of time series over a certain amount of time. According to Banerji and Hiris (2001: 334), "the growth rate cycle was based on the 'six month smoothed growth rate concept', which avoids the sort of extrapolation of the past trend needed in growth cycle analysis". The growth rate cycle therefore addresses the weakness of the growth cycle method to be accurately measured on a real-time basis.

This paper is not concerned with recalculating the reference turning points to track the South African business cycle, a function which the South African Reserve Bank (SARB) has performed exceptionally well since they first published a chronology of business cycle peaks and troughs in 1970 (Smit and Van der Walt 1970). We will simply take the reference turning points as published by the SARB as given and briefly note how this series is calculated[2]. According to Venter (2010), the SARB uses the computer algorithms developed by Bry and Boschan (1971) to calculate turning points, dependent on the reference series meeting the following criteria:

1. a phase duration (peak to trough or trough to peak) must be at least 5 months,

2. a cycle duration (peak to peak or trough to trough) must be at least 15 months,

3. in the case of a flat turning point zone or double peak or trough the most recent value will be selected as the turning point, and

4. extreme values are ignored if their effect is brief and fully reversed (Nilsson and Brunet 2006: 17).

[2]Detailed discussion on how the SARB determines reference turning points can be found in Smit and Van der Walt (1970) and Venter (2005).

The SARB has from the outset "monitored cyclical changes in the South African economy in terms of growth cycles" (Venter 2005: 61) and not in absolute terms as per the classical approach. This implies that their reference turning points distinguish between upward phases, where aggregate economic activity increased by more than its long-term growth trend, and downward phases, where aggregate economic activity increased by less than its long-term growth trend (Venter 2005). Should the SARB's three published composite business cycle indicators (the leading, coincident and lagging indicators) point to a possible turning point, two comprehensive indices, the historical and current diffusion indices, are constructed in order to "confirm or refute the occurrence of such a reference turning point in the business cycle" (Venter 2005: 63). Table 1 shows the South African business cycle phases as calculated by the SARB since 1968.

Zarnowitz and Ozyildirim (2001:i) distinguish between business cycles, defined as "sequences of expansions and contractions in the level of general economic activity", and growth cycles, defined as "sequences of high and low growth phases" (2001:i) which can be measured as "fluctuations in the deviations of the principal indicators around their generally rising trends" (2001: 2). In spite of the caveat mentioned by Zarnowitz (1992), that evidence from a number of independently compiled indicators are likely to be more reliable than evidence from any individual series, they argue that there are important interactions between business cycles and growth cycles and that "cyclical slowdowns and booms deserve to be analysed along with classical recessions and expansions" (2001:i). The output gap can possibly serve as one such principal indicator of high and low economic growth phases (or cyclical booms and slowdowns), and might therefore be able to complement the classical business cycle approach in measuring economic activity. Defining an upward phase, or economic expansion, as a positive output gap and a downward phase, or economic contraction, as a negative output gap yields Table 2 for the sample period 1980 – 2012.

As is immediately obvious, the output gap series is significantly more volatile than the official business cycle series. Over the sample period the official business cycle experienced 5 full cycles, whereas the output gap series experienced 10 full cycles. This was to be expected, given the nature of the data underlying these two measures. The business cycle is calculated by essentially aggregating a number of economic time series, imparting a natural smoothness, whereas the output gap series is calculated using only real GDP. Furthermore, the output gap series is exclusively focused on the information content of the single underlying series, and is not subject to the rigorous Bry-Boschan algorithm and its requirements as is the official business cycle. Clearly therefore, the constructed output gap measure cannot replace the official business cycle series. While elements of the output gap can be shaped by the business cycle, the output gap could just as well amplify the business cycle, implying a two-way relationship between the two series. However, in the spirit of Zarnowitz and Ozyildirim's (2001) argument the information contained in the output gap series might be of some value in complementing the official business cycle. The output gap's higher frequency and relative simplicity to calculate are therefore advantages that could be capitalised on. The remainder of this paper is therefore concerned with predicting changes in economic activity as measured by the output gap – and not the formal business cycle as is the standard approach – with the view of providing an additional source of information for researchers and policymakers.

Related to Zarnowitz and Ozyildirim's (2001) connection between the business cycle and the output gap is the fact that a recession is popularly defined and often reported in the media as "two consecutive quarters of negative economic growth" (The Economist 2001:13, Mohr 2010:120). While South African economic growth has slowed significantly over the last number of years, corresponding to a slowdown in global economic growth, it has last recorded negative real GDP growth in the second quarter of 2009 of -1.4% (SARB). Real GDP growth in the two quarters preceding 2009Q2 was also negative, with the economy contracting by -2.3% and -6.1% for 2008Q4 and 2009Q1 respectively. This poor economic performance is also substantiated by the protracted slowdown as measured by the output gap series (see Table 2 above). It was therefore widely reported that South Africa entered a recession during early-2009. The reality is, however, that by early-2009 South Africa had already formally been in recession for over a year (see Table 1). According to the NBER approach a recession is simply the period between a peak and a trough, which depends on the location of the peaks and troughs as informed by the various indicator series. Since economic growth is only one of a number of variables evaluated by the SARB in establishing turning points of the South African business cycle, the "two-consecutive-quarters" rule remains a rough approximation or rule-of-thumb at best. Subsequently the South African business cycle is still formally experiencing an upswing in spite of continued poor economic performance after the 2009 recession.

3 Money, currency, and economic activity

3.1 The role of money in economic activity

The role of the central bank in the provision of notes and coin (often called cash or currency) is often underestimated, even neglected, when discussing the roles and responsibilities of central banks. Leading international as well as local textbooks such as Mishkin (2010), Cecchetti and Schoenholtz (2010) as well as Van der Merwe, Mollentze, Rossouw, Leshoro and Vermeulen (2014) and Van Wyk, Botha and Goodspeed (2015) provide only a cursory glance at the central bank's function of providing quality notes and coin for circulation. Literature on central banking focuses more on the central bank's overarching function of regulating a country's money supply. While it is acknowledged that the money supply consists of both demand deposits and currency in circulation (M = D + C), the role of the cash or currency component is explained away owing to its small size relative to deposits. Currency in circulation in South Africa, as measured by banknotes and coin in circulation published as the South

African Reserve Bank's (SARB) monthly KBP1000M series, comprised only 4,4% of the total M3 money supply in December 2014. This ratio was 5,3% on average since January 1980, but it has been steadily decreasing from a high of 7,3% in December 1995 to 3,5% in July 2008. Since then this ratio has increased again, but averaged only 3,9% from July 2008 – January 2015. Mishkin (2010: 345) argues that "(b)ecause deposits at banks are by far the largest component of the money supply, understanding how deposits are created is the first step in understanding the money supply process." The analysis then shifts to explaining how commercial banks create money through the issuing of new demand deposits and the central bank's role in attempting to "steer" the actions of commercial banks in this process through monetary policy and its control over the monetary base and the discount lending rate. It continues by discussing how money creation subsequently influences economic activity and inflation, with virtually no further discussion of the role of currency in circulation on economic activity. This is also the standard approach in many other widely-used textbooks (see for instance Cecchetti and Schoenholtz 2010 or Van der Merwe et al. 2014).

The aim of this paper is not to criticise the current philosophies in the teaching of introductory monetary economics; on the contrary, it agrees with the emphasis placed on deposit creation in the money creation chain due to its sheer magnitude relative to currency in circulation, and with the focus on the importance of containing inflation. But the importance of the cash component should not be underestimated. This paper proposes that currency in circulation can serve as a valuable predictor of economic activity and therefore deserves more than the cursory glance afforded in contemporary analyses of monetary economics. Finally, since a significant proportion of a central bank's resources is spent on maintaining this cash function, it is envisaged that this model might be able to leverage an already-sunk cost and provide an additional source of information for policymakers.

3.2 Economic activity in South Africa

Based on Zarnowitz and Ozyildirim's (2001) suggestion that business cycles should be analysed along with growth cycles, there could conceivably exist a complementary relationship between the business cycle and the output gap. Figure 1 indicates that the output gap generally corresponds quite well to the South African business cycle as categorised by the SARB. The output gap is also closely mirrored by movements in the leading economic indicator (LEI). A slowdown (acceleration) in economic activity, as witnessed by a decrease (increase) in the output gap, is generally present in the initial stages of a recession (expansion). A negative output gap is present in all the upswing phases, but this perhaps reflects the gradual restoring of the economy by growing itself out of the preceding recession. Highs (lows) in the output gap strongly correspond to the turning points of the economic expansions (recessions), or the peaks (troughs) of the business cycle. The output gap is often at its biggest near the end of an upswing phase, while it usually reaches a minimum right at the end of a recession. A positively-increasing (negatively-increasing) output gap also corresponds to an increase (decrease) in the leading indicator. Figure 1 shows that the output gap falls during every recession, but that there are also instances of the output gap falling outside of recessions. This is consistent with Zarnowitz and Ozyildirim's observation that "all recessions involve slowdowns, but not all slowdowns involve recessions" (2001: 2).

An obvious anomaly is the sharp economic slowdown as witnessed by the protracted negative and falling output gap between 2002 and 2005, a contraction of 34 months according to the output gap measure in Table 2, but which is not officially classified as a recession. The slowdown is noted by Venter (2005), yet it did not qualify as a "downward phase[s] of the business cycle, according to the official definition of a business cycle" (2005: 69). Even though the fall in the leading indicator[3] points to a possible slowdown, neither the amplitude nor scope met the three Ps criteria, and therefore this slowdown was not formally classified as a recession. Economic growth was also never negative during this period, even though it was somewhat below trend. Venter (2005: 62) warns that "important economic events and developments occurring in the vicinity of a possible turning point... must be considered", and that certain "statistical methods employed may not even indicate the occurrence of a turning point". Venter (2005) acknowledges poorer economic performance during this period due to primarily the depreciation in the rand from January 2002 to late-2004 and weak economic growth in the euro area where South Africa's major trading partners are situated. Interestingly, a number of related studies have (falsely) predicted a recession for the period 2002-2005. Aziakpono and Khomo (2007) and Clay and Keeton (2011) used the yield spread, as measured by the difference between long- and short-term interest rates, to predict the probability of a recession occurring. While their estimations predicted all actual recessions accurately, their models independently both predicted a recession for 2002-2005. This has led to some observers questioning the credibility of the yield curve in predicting economic activity. Zarnowitz and Ozyildirim (2001: 8) however warn that "these apparent 'false signals' in leading indicators are not random: most of them are associated with turning points in growth cycles", further highlighting the importance of evaluating business cycles not in isolation but in conjunction with growth cycles.

Figure 2 highlights the co-movement of the LEI and growth in real currency in circulation relative to the business cycle. While not every slowdown in real currency growth leads to a recession, every recession is associated with slower growth in real currency in circulation. This growth rate also appears to mirror movements in the LEI, albeit at a slightly different horison.

Finally, Figure 3 replaces the formally dated recessions with the constructed

[3] According to Venter (2005:63) "the first sign of a possible turning point in the business cycle is usually when the composite leading business cycle indicator clearly changes direction for a period of at least six months". The composite leading indicator peaked at 108.0 in November 2002 and fell to a low of 99.4 in May 2003, exactly a 6-month change in direction. This was followed by a similar but smaller change in direction of the composite indicator, from 109.6 in February 2003 to 108 in June 2003, a fall of 5 months.

output gap series, where the shaded areas represent a negative output gap or slowdown in economic activity. Given the volatility in currency growth, which has somewhat more turning points than the formal recessions, it is expected that the relatively higher frequency output gap series will be more accurately tracked by currency growth. Indeed, virtually all episodes of economic slowdowns – as measured by a negative output gap – are associated with or preceded by a lower growth rate in real currency in circulation.

Almost every peak in the growth rate of real currency in circulation, representing the start of a contractionary phase in real currency growth, is followed by a negative output gap at a few months' lag. Similarly, a trough, which represents the start of an expansionary phase in real currency growth, is followed by a positive output gap. Table 3 shows the lead times of both real currency growth and the LEI with respect to the turning points in the output gap reference series.

Both the LEI and currency growth lead upswings in economic activity by a larger magnitude than downswings on average. In most instances of turning points the LEI also appears to lead economic activity by a few months more than currency growth. Only one out of the twenty turning points (January 1996) is lagged by currency growth.

4 Methodology and approach

The econometric analysis follows the methodology pioneered by Estrella & Hardouvelis (1991) and subsequently used in the South African context by, among others, Moolman (2002), Aziakpono and Khomo (2007) and Clay and Keeton (2011). It involves estimating a probit model to predict the probability of a slowdown in economic activity using some indicator or signalling variable. The variable being predicted can take on only two possible values, indicating whether the economy is slowing down or not. Previous research in the South African context have been mainly concerned with testing whether the yield spread (difference between short- and long-term interest rates) can successfully predict recessions. Instead of forecasting the probability of a recession occurring, our model attempts to predict the probability of a negative output gap. Our model also replaces these authors' explanatory variable (the yield spread) with two measures of the money supply in the economy: growth in real currency in circulation and growth in the real money supply (M3). The intuition behind the economic theory is quite straightforward and is derived from the classical equation of exchange

$$M.V \equiv P.Y \tag{1}$$

where M = the nominal money supply, V = velocity of money, P = the price level and Y = aggregate output (Fisher 1911). Rewriting the equation in real terms (dividing by the price level) yields

$$\frac{M}{P}.V \equiv Y \tag{2}$$

This identity clearly indicates that there is an expected proportionate relationship between the real money supply and aggregate output, *ceteris paribus*. The argument here is not that money is necessarily non-neutral in the long run; however, in the context of this analysis concerned with probability forecasting it is postulated that money is not neutral in the short run. Based on this identity, if the real money stock grows significantly economic activity can be expected to increase. The converse also holds. Because both M3 and the amount of currency in circulation are highly seasonal, the model uses the yearly (month-to-month) growth rate in these series. The real series are obtained by simply deflating the monthly nominal series with the consumer price index (CPI). While currency in circulation forms but a small part of the total money supply (M3), it would be of interest to test whether the two variables interact with aggregate economic activity in similar or different ways. It is expected that currency in circulation, being the significantly more liquid variable, should influence economic activity at a shorter time horizon than M3, but perhaps to a lesser degree due to its relatively small size.

Following Clay and Keeton (2011: 178), the money supply (real currency growth or real M3 growth) might therefore be a predictor of the binary variable Z_t, which indicates that there is a good chance of an economic slowdown occurring if $Z_t = 1$, and a good chance that an economic slowdown will not occur if $Z_t=0$. The standard linear regression model is defined as:

$$Z_t = \alpha + \beta X_{t-q} + \varepsilon_t \tag{3}$$

where Z_t represents the unobserved dependent variable that determines the occurrence of an economic slowdown/expansion at time t. X_{t-q} denotes the explanatory variable, representing our measure of the money supply lagged at time t-q. The integer q represents the lag length required for the money supply to become a predictor of a slowdown that might occur several periods ahead. ε_t is a normally distributed error term. The output gap is used to assign each economic slowdown to $Z_t = 1$ (corresponding to a negative output gap) and each acceleration to $Z_t = 0$ (a positive output gap). The suggestion is that a positive output gap (i.e. $Z_t = 0$) represents an upswing or expansion in economic activity. The estimated equation therefore takes the form

$$P(Z_t = 1) = F(\alpha + \beta X_{t-q}) \tag{4}$$

where $P(Z_t = 1)$ represents the probability that a slowdown will occur conditional upon the observed value of the explanatory variable X lagged q periods ahead. F is the cumulative distribution function and the parameters are estimated by maximum likelihood.

Clay and Keeton (2011: 179) point out that in a simple probit model, "the error terms are assumed to be independent and evenly distributed around the mean of zero". This is, however, not a plausible assumption. Dueker (1997) argues that the error terms in time series data are likely to be highly correlated. This issue is addressed by the modified probit model, which involves "adding a lag of the dependent variable to the simple probit model in order to remove the serial correlation that may exist between the error terms" (Clay and Keeton 2011: 179). The modified probit model takes the form

$$P(Z_t = 1) = F(\alpha + \beta X_{t-q} + \beta_2 Z_{t-1}) \tag{5}$$

As this is no longer a linear model, the usual R^2 is not a suitable measure of goodness of fit. Estrella (1998) suggests an alternative measure for goodness of fit for a non-linear estimation, here termed the *Estrella* R^2, which is calculated as follows:

$$Estrella\ R^2 = 1 - (L_n/L_c)^{-(\frac{2}{N}L_c)} \tag{6}$$

where L_n is the log-likelihood value of the estimated equation, L_c is the log-likelihood of a constrained model containing only the constant and N represents the number of observations in the model.

The simple and modified probit models are estimated using two measures of the money supply: the growth rate in real currency in circulation, and the growth rate in real M3. The forecast horizons range from 1 to 12 months, and the optimal forecast horizon is interpreted as the lag length which produces the highest *Estrella* R^2.

5 Empirical results and interpretation

5.1 Currency in circulation

Table 4 presents the results for the simple probit model, using growth in real currency in circulation as the explanatory variable. The *Estrella* R^2 is the highest at 6 months, therefore growth in real currency in circulation best predicts economic activity up to 6 months ahead. Based on the probability values in Table 4 the relationship is clearly statistically significant.

The estimated equation of this simple probit model at 6 lags

$$P(Z_t = 1) = 0.331 - 8.154X_{t-6} \tag{7}$$

The negative coefficient on the explanatory variable is consistent with the *a priori* expectation that there is an inverse relationship between a high growth rate in real currency in circulation and a slowdown in economic activity. Comparing these forecasted probabilities with actual slowdowns in South African economic activity, as measured by the output gap, yields Figure 4.

As a result of the high frequency of the monthly data the series is not very smooth, yet the predicted probabilities of a slowdown fit the actual data reasonably well. The predicted probabilities are not as significant as one would have hoped, since the predicted probabilities only range between 81,6% and 4,5% and does not approach the upper probability of 100%. However, virtually every slowdown, as represented by the shaded areas in the figure, corresponds to an increased probability of a slowdown occurring as predicted by the model and vice versa. If real currency in circulation grows by less than 4% the probability of a slowdown occurring 6 months later exceeds 50% (see Appendix A3). If real currency in circulation contracts by more than 2% the probability of a slowdown occurring 6 months later is more than 70%.

The results of the modified probit model, using growth in real currency in circulation as the explanatory variable, are presented in Table 5. The highest *Estrella* R^2 value is at a 1-month lag, which is similar to the findings of Clay and Keeton (2011). However, a graphical plot of the forecasted probabilities at 1 lag is not very helpful, as it predicts a virtually 100% or 0% probability of a slowdown occurring (see figure 5).

This can be attributed to the exaggerated effect of the lagged dependent variable, the sole purpose of which is to remove serial correlation in the error term due to the non-linear nature of the model. Furthermore, a one month forecasting period is not expected to provide significantly valuable information, especially since the data is published only at a one month lag. Subsequently it would be more appropriate to examine the modified probit model at the same lag length as the simple probit model. The estimated equation of the modified probit model at 6 lags is

$$P(Z_t = 1) = 0.336 - 8.570X_{t-6} + 1.356Z_{t-6} \tag{8}$$

Comparing these forecasted probabilities with actual slowdowns in South African economic activity yields the following graphical illustration in Figure 6.

The modified probit model has significantly better predictive accuracy than the simple probit model, with the added advantage of a clearer distinction between high and low probabilities. It is also the preferred model given its ability to correct for autocorrelation.

Similar to the simple probit model, the modified probit model falsely predicts two slowdowns. The modified probit model indicates a 75% probability of a slowdown during 1996 and 77% during late 2006. These are, however, within a year after the categorised downswings have ended and are therefore not of significant concern. During the period under consideration there were 19 instances of real currency in circulation contracting by more than 5%. All 19 of these contractions occurred either during or right before a slowdown.

5.2 M3

Growth in real M3 is also a good predictor of economic activity, as is evidenced by Tables 6 and 7. The crucial difference, however, between real M3 growth and real currency growth is its forecasting horizon. Based on Estrella's R^2 criterion, the optimal forecasting horizon of real M3 growth is 9 months, slightly longer than the 6 month horizon of real currency growth.

The estimated equation of this simple probit model at 9 lags is

$$P(Z_t = 1) = 0.453 - 8.288X_{t-9} \tag{9}$$

The negative coefficient on the explanatory variable is consistent with the *a priori* expectation that there is an inverse relationship between a high growth rate in the money stock and a slowdown in economic activity. Comparing these forecasted probabilities with actual slowdowns in South African economic activity yields Figure 7.

Once again the series is not very smooth, yet the predicted probabilities of a slowdown fit the actual data quite well. If the real money supply grows by less than 6% the probability of a slowdown occurring 9 months later exceeds 50% (see Appendix A3). If the real money supply contracts by more than 5% the probability of a slowdown occurring 9 months later is more than 80%.

Finally, the modified probit model using growth in the real money supply as explanatory variable is presented in Table 7. Similar to the model of real currency growth the Estrella R^2 criterion suggests a 1 month lag to be the optimal forecasting horizon. The same deficiencies, however, is applicable here and therefore the modified probit model with the same suggested lag length as the simple probit model was selected.

The estimated equation of the modified probit model at 9 lags is

$$P(Z_t = 1) = 0.064 - 7.210X_{t-9} + 0.652Z_{t-9} \tag{10}$$

Comparing these forecasted probabilities with actual slowdowns in South African economic activity yields Figure 8.

Similar to the result obtained in the real currency growth model, the modified probit model for growth in real M3 fits the data quite well, with the added benefit of clearer distinction between high and low predicted probabilities.

Clay and Keeton (2011) extend their analysis of the forecasting ability of the yield spread by introducing additional explanatory variables. They introduce the Johannesburg Stock Exchange (JSE) All-Share Index (ALSI), the SARB's Leading Economic Indicator (LEI) and M3 to predict the probability of a recession occurring. They rank the models according to their Estrella's R^2 values, indicating that the model with the higher Estrella R^2 is deemed the superior model in terms of predictive power, and find that "the yield spread is the best variable at providing information about the likelihood of a downswing" (2011:186). Using this same criterion here it can be concluded that real M3 is a superior predictor of economic activity than real currency in circulation. Our calculated Estrella R^2 in the simple probit model for real M3 at 9 lags is 0.216, which is slightly higher than the calculated Estrella R^2 for real currency in circulation at 6 lags of 0.167. This is perhaps not surprising, given the small proportion of M3 which consists of currency in circulation, reflecting the abundance of information contained in the total money supply relative to currency in circulation. However, stationarity tests performed on the growth rate in real M3 are inconclusive regarding its stationarity (see Appendix A2), casting some doubt over the legitimacy of using real M3 growth as an explanatory variable in this context. Nonetheless, real currency in circulation has been shown to have a statistically significant relationship with economic activity, and, given its relative ease to measure, can serve as a valuable and proactive additional predictor of economic activity.

6 Conclusion

This paper examined business cycles and economic activity in the South African context. It discussed the dating procedures used by the SARB to establish reference turning points in the South African business cycle, and also highlighted the importance of evaluating other indicators, such as the output gap, complementary to the business cycle. Furthermore, it analysed the ability of the money supply, as measured by the growth in real M3 as well as growth in real currency in circulation, to predict the probability of an economic slowdown occurring. Assigning a negative output gap to an economic slowdown, it was established that growth in real currency in circulation can accurately predict economic activity up to 6 months ahead, while growth in real M3 is a good predictor of economic activity up to 9 months ahead.

The magnitudes of the growth rates also play an important part in predicting economic activity. If real currency in circulation grows by 20%, the probability of a slowdown occurring in 6 months is a mere 10%. A growth rate of 4% or less predicts a 50% chance of a slowdown, and a growth rate of 1% predicts a 60% chance of a slowdown.

A caveat is that the data necessary to populate this model are only published at a slight lag, somewhat shortening the model's forecasting horizon. Nominal currency in circulation and M3 are published within one month, as is CPI which is used to calculate the real values of these series. Subsequently the "effective" forecasting horizons of this model are 5 months and 8 months for real currency in circulation and real M3 respectively.

Other models attempting to predict South African recessions using the yield spread have lost some credibility given that they falsely predicted a recession for 2002-2003. Our model also predicts a slowdown for the same period. While this period was not classified as a recession, by using the output gap instead of formally dated recessions we are able to accurately predict this slowdown, perhaps restoring some credibility to the yield curve and those other models which also detected a slowdown but had to explain why it did not coincide with a recession.

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Table 1: Business cycle phases of South Africa since 1968

Upward phase			Duration (months)	Downward phase			Duration (months)
Jan 1968	-	Dec 1970	36	Jan 1971	-	Aug 1972	20
Sep 1972	-	Aug 1974	24	Sep 1974	-	Dec 1977	40
Jan 1978	-	Aug 1981	44	Sep 1981	-	Mar 1983	19
Apr 1983	-	Jun 1984	15	Jul 1984	-	Mar 1986	21
Apr 1986	-	Feb 1989	35	Mar 1989	-	May 1993	51
Jun 1993	-	Nov 1996	42	Dec 1996	-	Aug 1999	33
Sep 1999	-	Nov 2007	99	Dec 2007	-	Aug 2009	21
Sep 2009	-						

Source: SARB Quarterly Bulletin June 2014. S-155.

Table 2: Phases of economic activity in South Africa since 1980

Upward phase			Duration (months)	Downward phase			Duration (months)
				Jan 1980	-	Dec 1980	12
Jan 1981	-	Sep 1982	21	Oct 1982	-	Dec 1983	15
Jan 1984	-	Dec 1984	12	Jan 1985	-	Dec 1987	24
Jan 1988	-	Sep 1991	45	Oct 1991	-	Sep 1994	36
Oct 1994	-	Jun 1995	9	Jul 1995	-	Dec 1995	6
Jan 1996	-	Jun 1998	30	Jul 1998	-	Dec 1999	18
Jan 2000	-	Jun 2001	18	Jul 2001	-	Mar 2002	9
Apr 2002	-	Jun 2002	3	Jul 2002	-	May 2005	34
Jun 2005	-	Aug 2005	3	Sep 2005	-	Mar 2006	7
Apr 2006	-	Dec 2008	33	Jan 2009	-	Dec 2010	24
Jan 2011	-	Mar 2011	3	Apr 2011	-	Sep 2011	6
Oct 2011	-						

Source: Own calculations from SARB Quarterly Bulletin, various editions.

Table 3: Lead times of turning points in the output gap reference series[1]

Upward phases				Downward phases			
Turning point	Phase duration (months)	LEI (SARB)	Currency growth	Turning point	Phase duration (months)	LEI (SARB)	Currency growth
				Oct 1982	15	13	16
Jan 1984	12	18	3	Jan 1985	24	7	0
Jan 1988	45	33	22	Oct 1991	36	32	33
Oct 1994	9	26	26	Jul 1995	6	6	3
Jan 1996	30	4	-1	Jul 1998	18	15	0
Jan 2000	18	14	6	Jul 2001	9	18	13
Apr 2002	3	8	10	Jul 2002	34	2	2
Jun 2005	3	25	23	Sep 2005	7	8	11
Apr 2006	33	13	5	Jan 2009	24	27	24
Jan 2011	3	24	19	Apr 2011	6	11	3
Oct 2011	-	12	7				
Average:		17.7	12.0			13.9	10.5

Source: Own calculations from SARB Quarterly Bulletin, various editions.

Table 4: Simple probit (growth in real currency in circulation)

Months ahead	1	2	3	4	5	6	7	8	9	12
α	0.176	0.213	0.256	0.295	0.311	0.331	0.322	0.308	0.284	0.261
β	-4.240	-5.185	-6.301	-7.292	-7.639	-8.154	-7.793	-7.309	-6.553	-5.714
std err	1.192	1.209	1.229	1.251	1.260	1.287	1.271	1.258	1.239	1.228
z-Stat	-3.557	-4.290	-5.129	-5.829	-6.061	-6.335	-6.132	-5.808	-5.288	-4.654
Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log-l	-258.956	-255.212	-256.198	-250.248	-242.999	-240.122	-240.977	-242.470	-244.979	-246.181
Estrella R^2	0.075549	0.094000	0.089154	0.118300	0.153459	0.167299	0.163194	0.156006	0.143894	0.138076
L_c	-274.0771									

Table 5: Modified probit (growth in real currency in circulation)

Months ahead	1	2	3	4	5	6	7	8	9	12
α	-1.454	-1.074	-0.800	-0.617	-0.475	-0.336	-0.264	-0.199	-0.145	0.019
β	-7.045	-7.234	-8.084	-8.887	-8.569	-8.570	-7.778	-7.082	-6.215	-5.451
std err	2.177	1.780	1.629	1.565	1.470	1.424	1.353	1.311	1.273	1.242
z-Stat	-3.235	-4.064	-4.963	-5.680	-5.827	-6.016	-5.749	-5.403	-4.881	-4.389
Prob	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$β_2$	3.504	2.738	2.247	1.939	1.631	1.356	1.161	0.983	0.816	0.447
std err	0.250	0.194	0.173	0.163	0.154	0.147	0.143	0.139	0.137	0.134
z-Stat	13.992	14.110	13.005	11.872	10.625	9.215	8.137	7.049	5.964	3.336
Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Log-l	-66.791	-110.203	-141.822	-160.408	-179.183	-194.127	-206.052	-216.719	-226.780	-240.585
Estrella R^2	0.858	0.717	0.598	0.524	0.445	0.380	0.326	0.277	0.231	0.165
L_c	-274.0771									

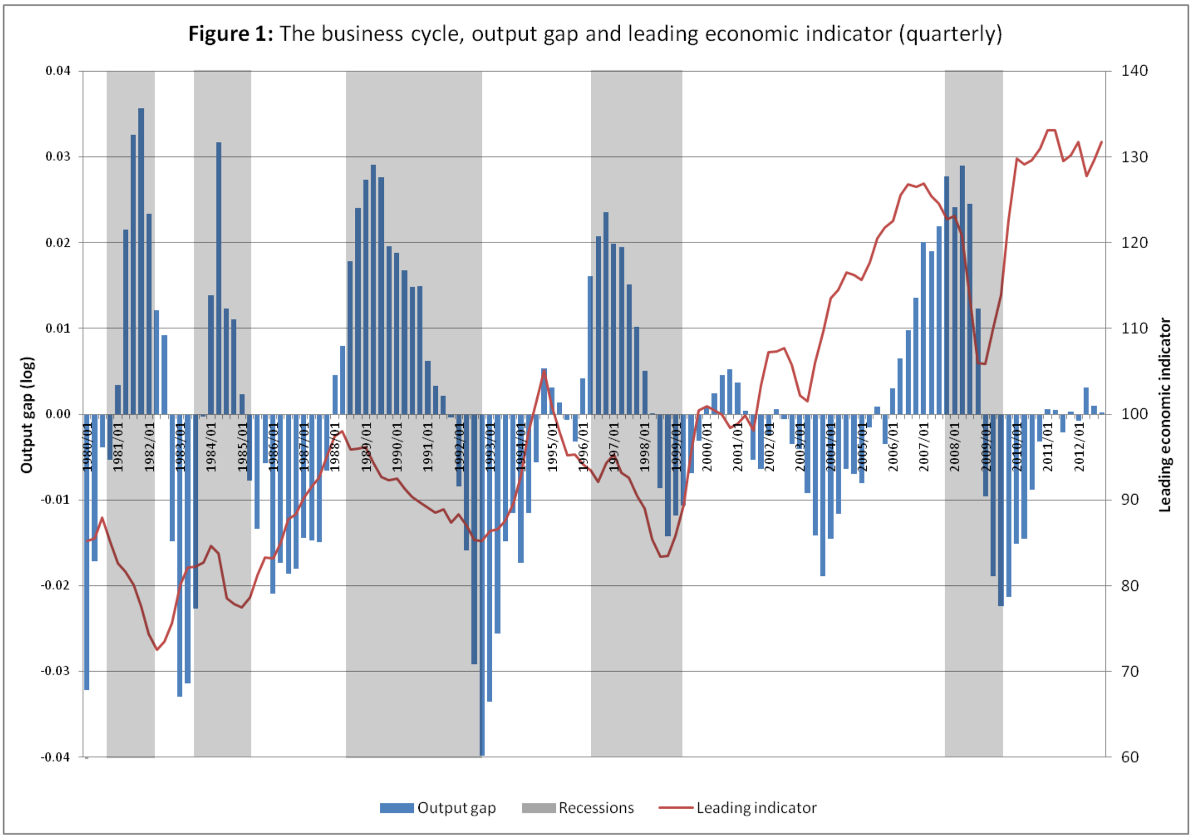
[1] In the event of a double-peak or –trough in currency growth in a single phase the most recent was chosen.

Table 6: Simple probit (growth in real M3)

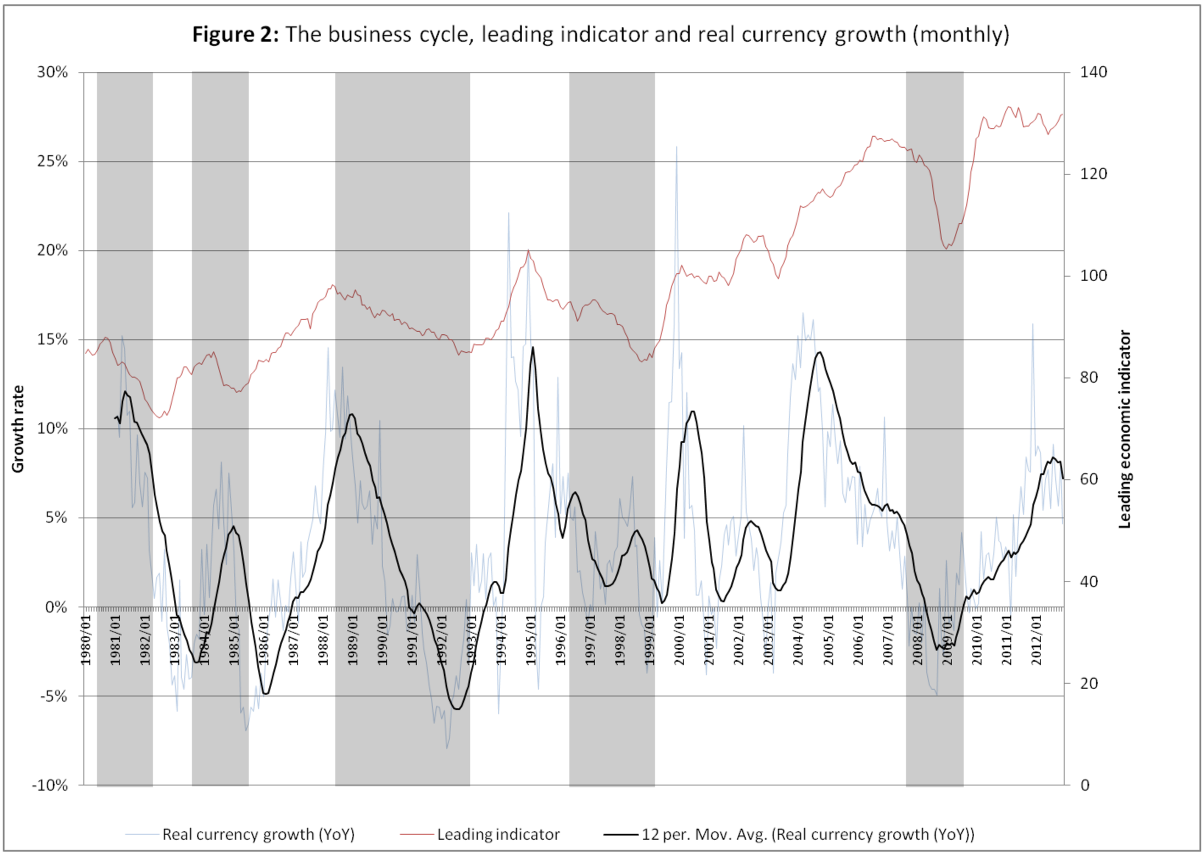
Months ahead	1	2	3	4	5	6	7	8	9	12
α	0.312	0.333	0.363	0.396	0.418	0.433	0.443	0.447	0.453	0.389
β	-6.090	-6.436	-6.958	-7.554	-7.910	-8.115	-8.224	-8.239	-8.288	-6.768
std err	1.066	1.077	1.093	1.110	1.120	1.126	1.128	1.128	1.131	1.083
z-Stat	-5.711	-5.978	-6.368	-6.804	-7.062	-7.207	-7.289	-7.306	-7.326	-6.250
Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log-l	-248.122	-245.618	-242.087	-237.943	-235.067	-233.077	-231.651	-230.807	-229.850	-236.532
Estrella R^2	0.128652	0.140802	0.157853	0.177742	0.191465	0.200927	0.207685	0.211677	0.216198	0.184482
Lc	-274.0771									

Table 7: Modified probit (growth in real M3)

Months ahead	1	2	3	4	5	6	7	8	9	12
α	-1.456	-1.055	-0.760	-0.554	-0.387	-0.237	-0.134	-0.037	0.064	0.216
β	-3.670	-4.259	-5.081	-5.968	-6.430	-6.753	-6.931	-7.027	-7.210	-6.190
std err	1.876	1.529	1.385	1.330	1.278	1.240	1.215	1.192	1.180	1.124
z-Stat	-1.957	-2.786	-3.669	-4.488	-5.030	-5.444	-5.706	-5.897	-6.111	-5.506
Prob	0.050	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
β_2	3.303	2.566	2.064	1.743	1.454	1.189	1.005	0.827	0.652	0.275
std err	0.224	0.182	0.163	0.155	0.150	0.145	0.143	0.142	0.141	0.140
z-Stat	14.728	14.133	12.634	11.218	9.721	8.173	7.012	5.830	4.619	1.964
Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050
Log-l	-70.59598	-115.186	-148.3158	-167.648	-184.237	-198.127	-206.318	-213.511	-219.092	-234.606
Estrella R^2	0.847046	0.698785	0.572588	0.493590	0.422932	0.361853	0.325042	0.292253	0.266519	0.193660
Lc	-274.0771									



Source: Own calculations from SARB Quarterly Bulletin, various editions.



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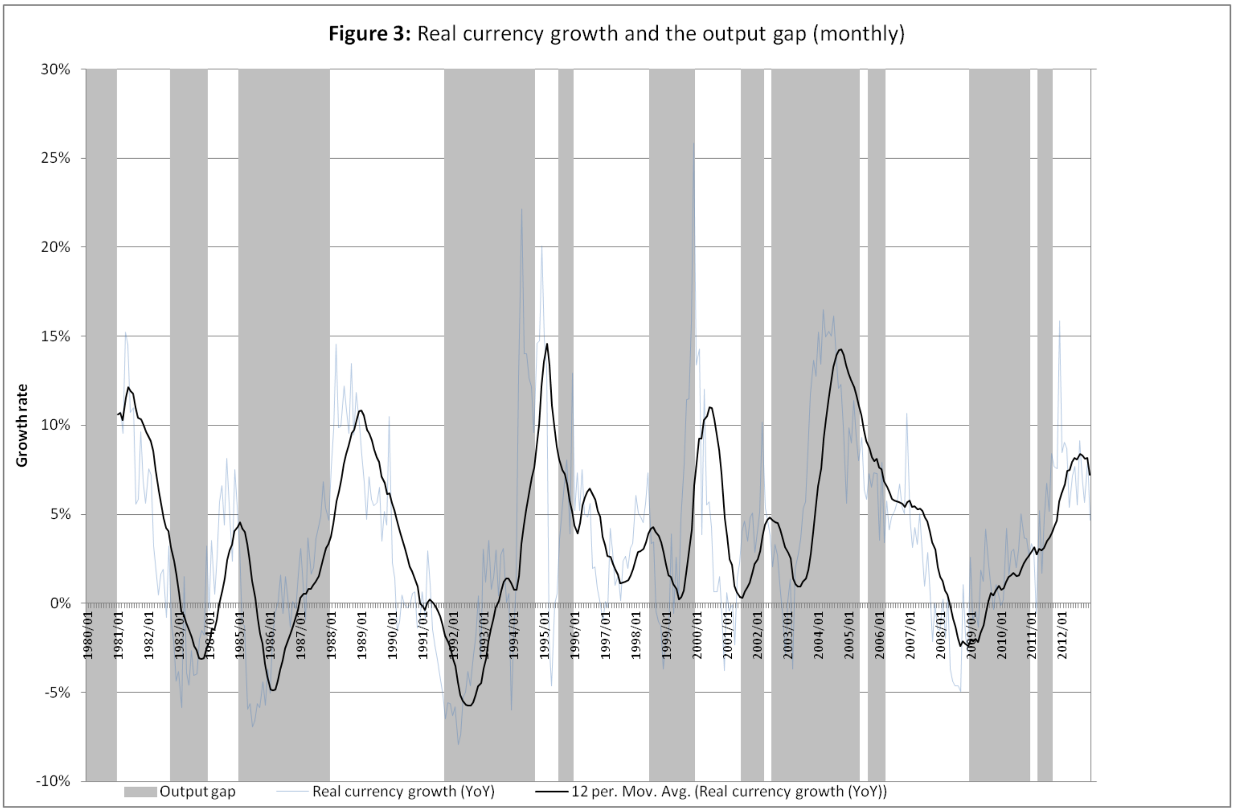


Source: Own calculations from SARB Quarterly Bulletin, various editions.

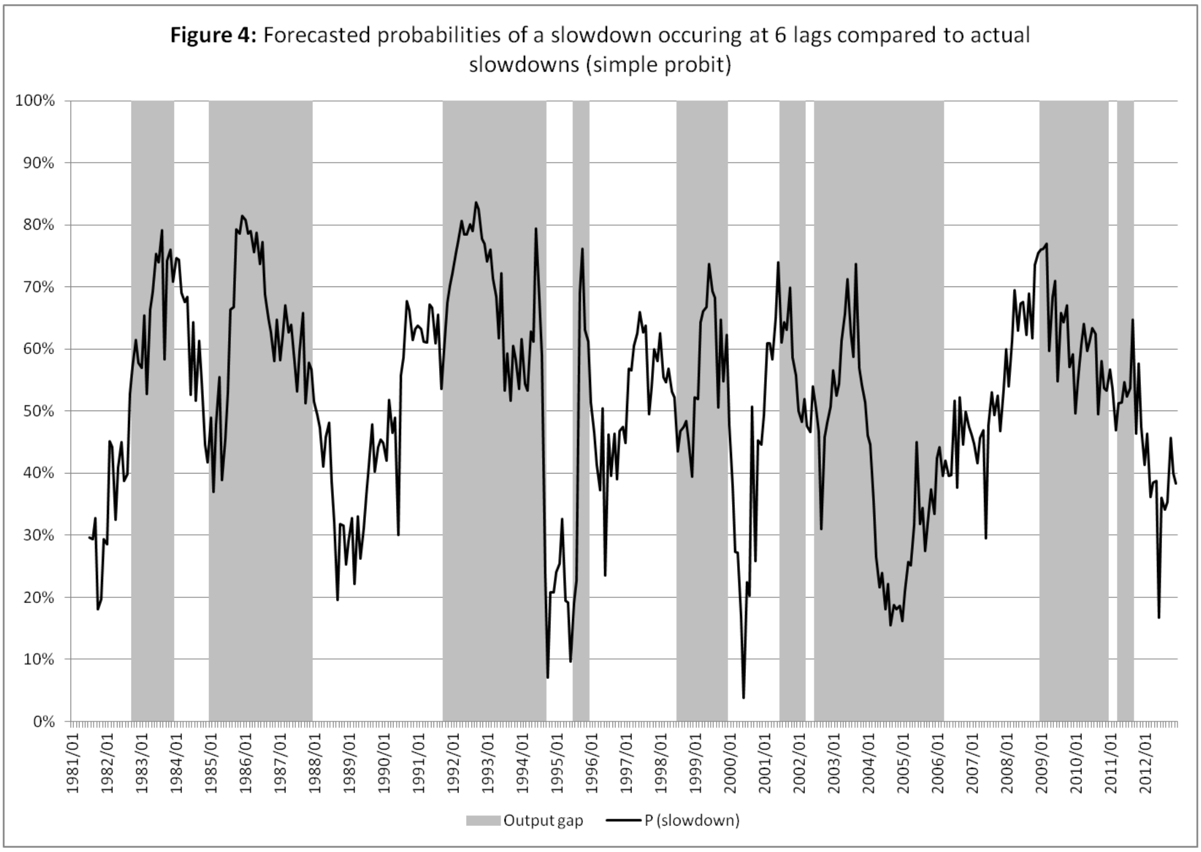


Figure 5: Forecasted probabilities of a slowdown occuring at 1 lag compared to actual slowdowns (modified probit)

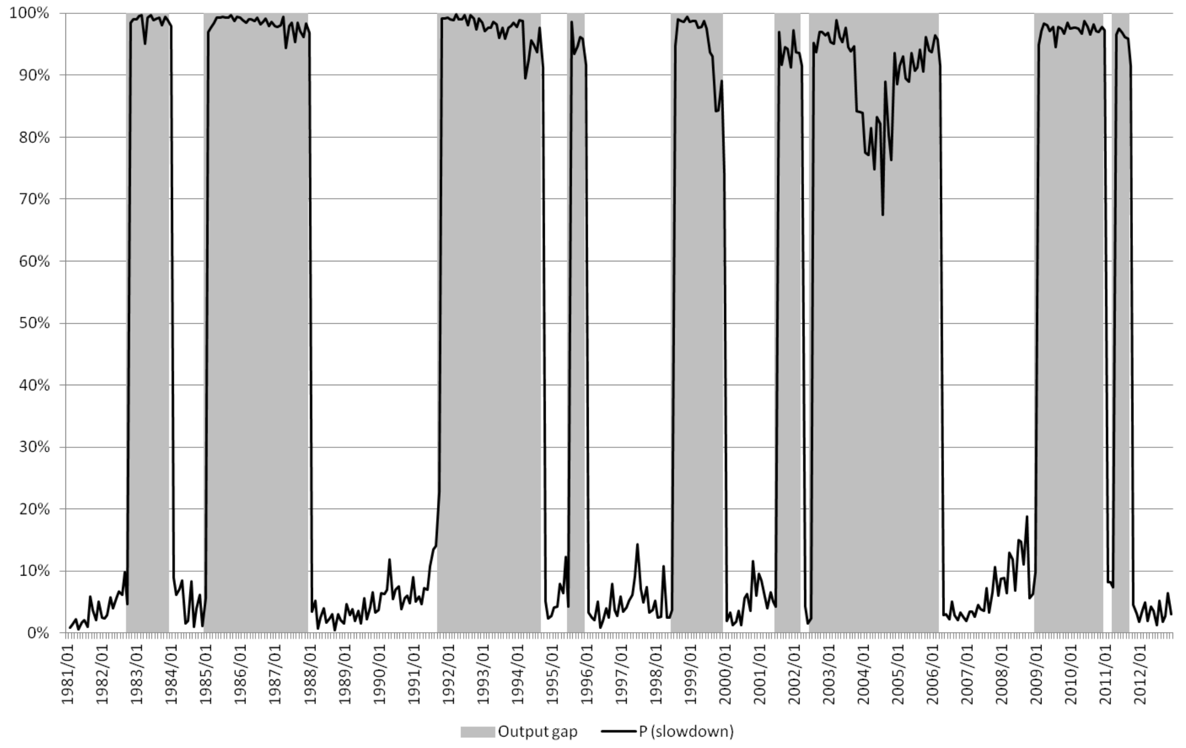


Figure 6: Forecasted probabilities of a slowdown occuring at 6 lags compared to actual slowdowns (modified probit)

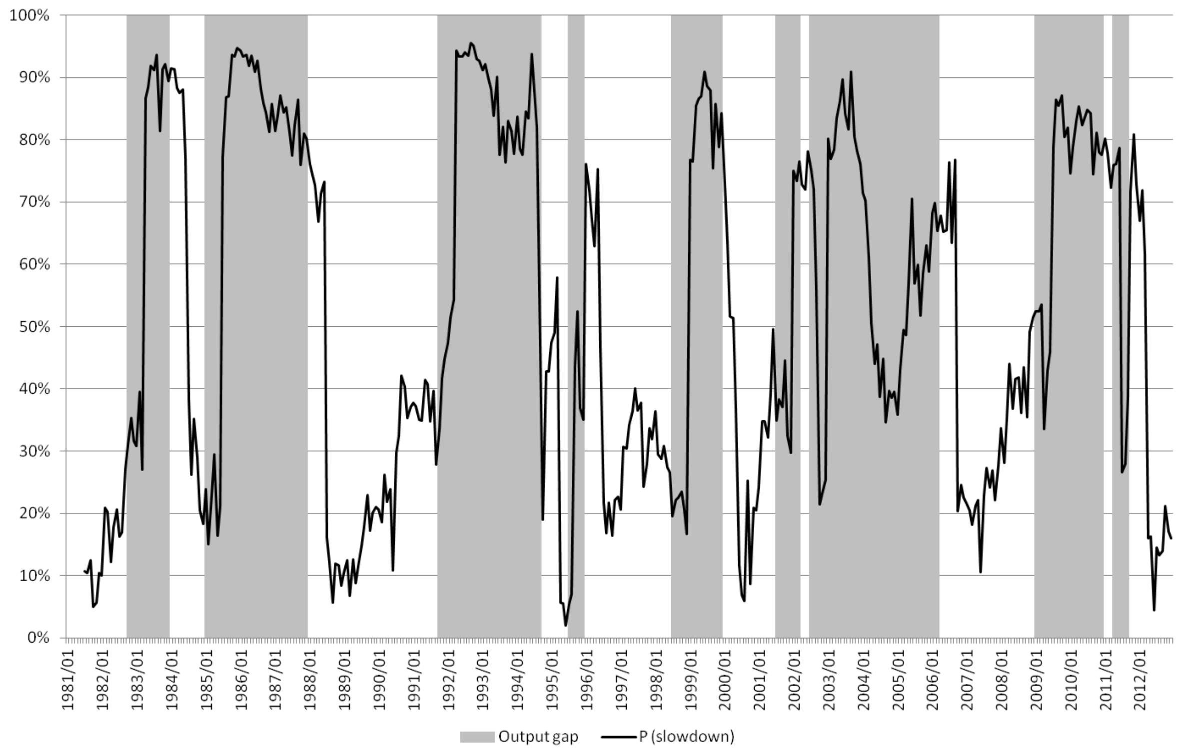


Figure 7: Forecasted probabilities of a slowdown occuring at 9 lags compared to actual slowdowns (simple probit)

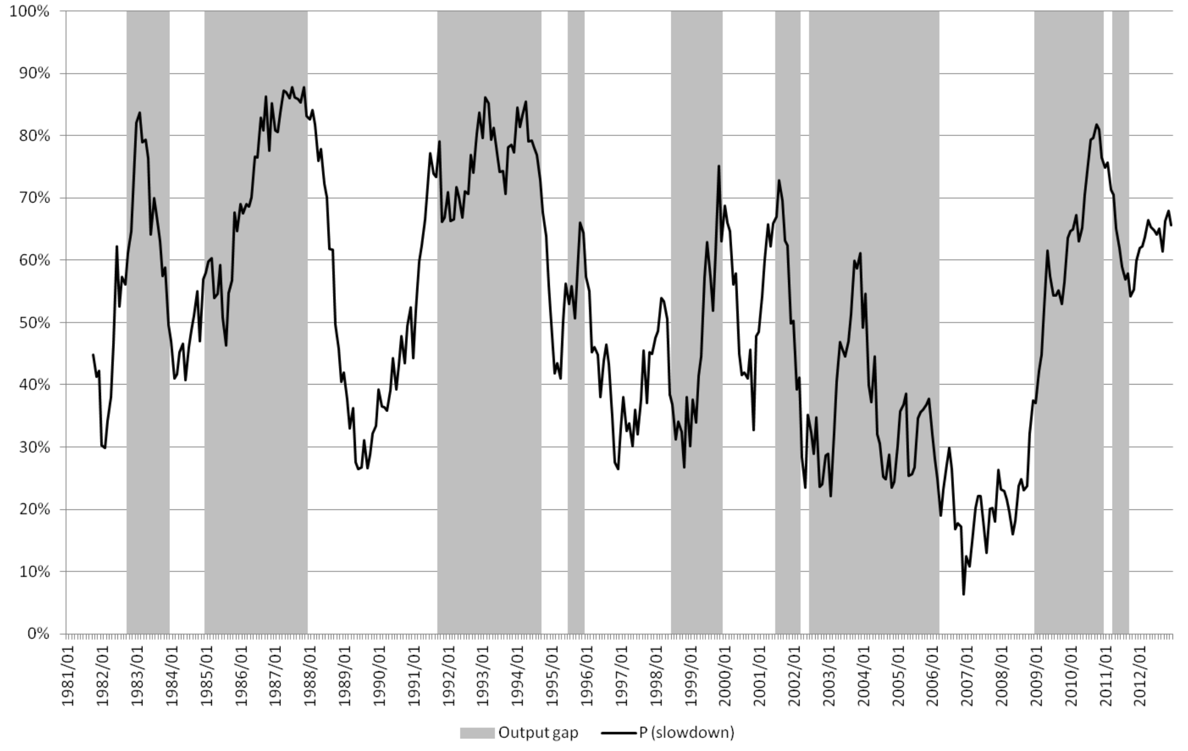
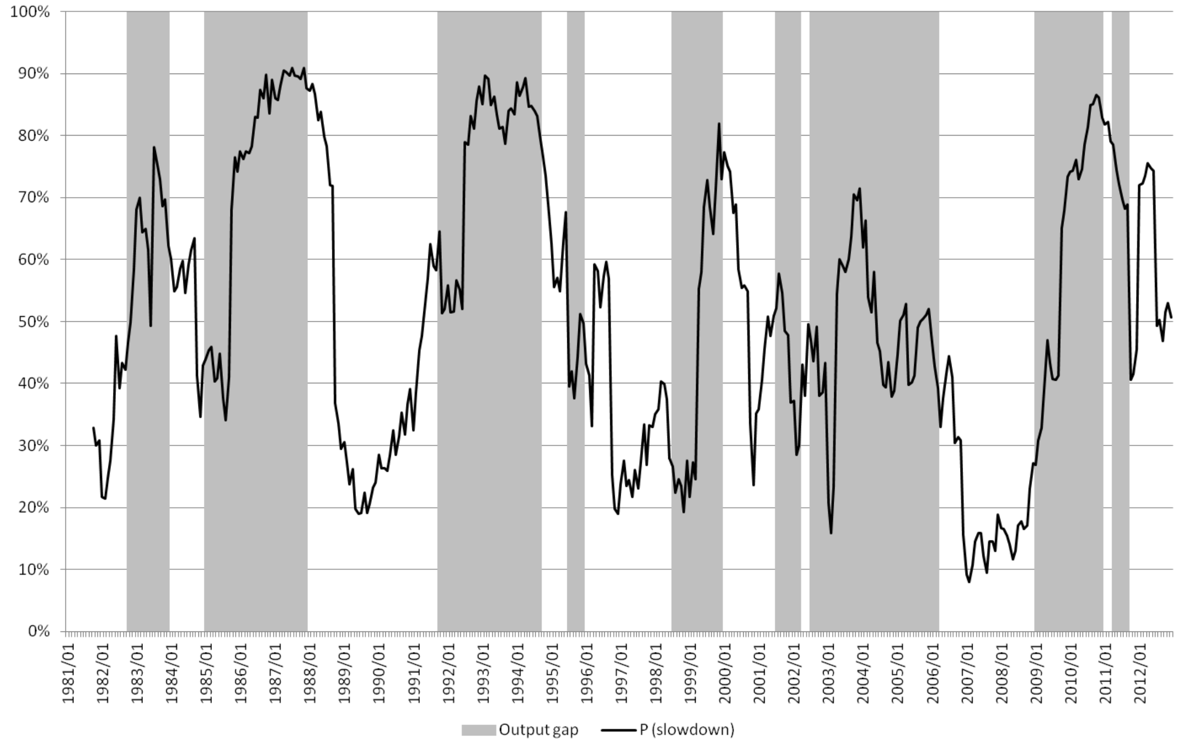


Figure 8: Forecasted probabilities of a slowdown occuring at 9 lags compared to actual slowdowns (modified probit)



Appendix

Real GDP, the LEI, currency in circulation and the M3 money supply data were sourced using the SARB's Quarterly Bulletin' online statistical query facility. The most recent currency in circulation and M3 money supply observations were obtained from the SARB's monthly publications of their Statement of Assets and Liabilities and the Monthly Release of Selected Data respectively. The CPI was obtained from Statistics South Africa's Consumer Price Index Statistical Release P0141.

A1. Calculating the output gap

One of the most popular modern techniques to detrend a time series involves using the Hodrick-Prescott (HP) filter (Hodrick and Prescott 1997). Viewing the time series y_t as the sum of a growth component g_t and a cyclical component c_t the HP filter minimises

$$\sum_{t}^{T} c_t^2 + \lambda \sum_{t}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \tag{1}$$

where *lambda* is positive. Hodrick and Prescott (1997) favour *lambda* = 144,000 for monthly and *lambda* = 1,600 for quarterly data. This approach was used to determine the trend in the natural logarithm of real GDP. The difference between the actual and HP filtered series yields the output gap. A dummy variable, representing an economic slowdown or expansion, was created by assigning 1 (one) to a negative output gap (i.e. actual real GDP < trend real GDP) and 0 (zero) to a positive output gap.

A2. Testing for stationarity in the explanatory variables

Table A2: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity tests

Series	Model	ADF	PP
Growth: Real currency in circulation	Trend	-4.228943 ***	-5.511912***
	Constant	-4.340392 ***	-5.613467***
	None	-3.563533 ***	-4.370620 ***
Growth: Real M3	Trend	-2.155274	-3.052292**
	Constant	-2.166865	-3.163029*
	None	-1.727365	-2.517722**

* *Significant at 10% level*
** *Significant at 5% level*
*** *Significant at 1% level*

A3. Probability table

Table A3 below lists the probabilities of a negative output gap occurring predicted by the different models for a range of growth rates in both real currency in circulation as well as real M3.

Table A3: Predicted probability of slowdown occurring

	Real currency in circulation	Real M3
Growth rate	Probability of slowdown occurring 6 months later (simple probit)	Probability of slowdown occurring 9 months later (simple probit)
-15%	94%	96%
-10%	93%	95%
-5%	77%	81%
-4%	74%	78%
-3%	72%	76%
-2%	69%	73%
-1%	66%	70%
0%	63%	67%
1%	60%	64%
2%	57%	61%
3%	53%	58%
4%	50%	55%
5%	47%	52%
10%	31%	35%
15%	19%	32%
20%	10%	29%
25%	4%	27%