HOW TO MINIMIZE THE EFFECT OF THE GLOBAL FINANCIAL CRISIS ON SOUTH AFRICA

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ABSTRACT
South Africa is a small open economy that is predominantly driven by international developments. There are a great number of specific factors that prevent our economy from achieving its potential. Accordingly, both our business cycle and outcomes in our financial markets are determined by global events. The global financial crisis (GFC) is an ongoing housing and financial crisis that was triggered by a marked increase in mortgage delinquencies and foreclosures in the U.S. It has had major adverse consequences for banks and financial markets worldwide since it became apparent in 2007. Furthermore, the root of the global financial crisis is financial institutions that underestimate the business cycle. This is the reason why we consider the output gap (a proxy for the business cycle). In this paper, we evaluate the usefulness of alternative estimates of the output gap for predicting the business cycle.

KEY WORDS
Output gap, business cycle, Hodrick-Prescott filter, ARIMA models, production function, global financial crisis.

1. Introduction
Before the global financial crisis (GFC), strong growth and low inflation combined with high profits, low default levels and strong capital reserves created favorable macroeconomic conditions. Also, large amounts of deposits flowed into the U.S. which funded residential mortgage loans (RMLs) in a low interest rate environment. Consequently, credit was easy to obtain, thus boosting the housing and credit market for a number of years. During 1999, the Clinton administration placed political pressure on Fannie Mae and Freddie Mac to start lending to low-income households. This pressure also fed through to the commercial financial institutions. Financial institutions mitigated the risks of subprime mortgages (i.e. loans to low-income households) by securitization of the subprime mortgages, which were then packaged as collateralised debt obligations (CDOs) and on-sold to various investors. Falling house prices and rising interest rates led to increasing numbers of people who could not repay their mortgages. Which cause investors to suffered losses. Investors in banks withdrew their equity and depositors tried to withdraw their cash deposits and banks became reluctant to lend to one another, not knowing how many bad loans could be on their rivals’ books. This caused solvency and liquidity problems for the exposed banks and 2.6 million Americans to lost their jobs during 2008. The GFC impact beyond the US losses were felt as far afield as Europe and Japan. The GFC has affected South Africa by slowing down growth, with certain components of the economy in recession and others in survival mode. Export earnings, GDP growth, investment, employment and smaller capital spending, i.e. the output gap, are affected by the crisis.

South Africa does not need a bailout of the banking or other sectors. What is needed is a focus on ensuring that financial institutions do not underestimate the business cycle. Although the output gap provided in our study is achieved by smoothing real GDP via the Hodrick-Prescott filter method (see [15]), we also verified our findings by using the more complicated potential output method using a production function approach (see, for instance, du Toit et al., 2006). Further discussion of output gap in a South African context is provided by [2], [4], [5] and [16]. The output gap for several OECD countries is investigated in [6] and [7]. As far as the calculation of output gap is concerned, [12] (see also [11], [13]) reviews the methods used to estimate potential output and the resulting output gaps for the calculation of structural budget balances. The split time trend method for estimating trend output is compared with two alternative methods, viz. the Hodrick-Prescott filter and potential output methods. The conclusion is that the latter method is best for estimating output gaps and for calculating structural budget balances, with the results obtained by smoothing real GDP providing a means of verification. [2] (see also [17]) examines growth performance in post-apartheid South Africa within a growth accounting framework and assesses future growth prospects. Near term prospects can be captured by potential output growth and the output gap. Furthermore, longer-term growth prospects can be determined on the basis of the full utilization of factors of production and the output gains that arise as these factors are more effectively utilized, for example, through structural reforms that enhance efficiency. The paper [4] provides estimates of potential output growth in South Africa since 1994 using both the time trend techniques and a production function approach.
function approach. This paper claims that the output gap provides statistically significant information for forecasting inflation and could thus be used to formulate macroeconomic policy. Growth accounting and regression analysis suggest that an increase in trend GDP growth after 1994 is attributable to higher total factor productivity (TFP) growth driven by trade liberalisation and greater private sector participation. [5] provides estimates of potential real GDP growth in South Africa based on alternative methodologies, including a production function approach that is standard in the literature. The estimates suggest that from 1994-2001 potential output growth was around 2.5 to 2.75 percent annually, and that in 2001 the output gap was around zero. In order to elucidate South Africa’s longer-term growth prospects, [5] analyses the sources of real GDP growth in the country based on previous work in [16] (see also [19]). A striking fact is that the average annual growth rate of real GDP has increased significantly since 1994, rising from 1 per cent in 1980-1993 to 2.7 percent in 1994-2001. The increase can mainly be attributed to TFP growth (improvements in efficiency and technology) rather than to increases in the factors of production (like employment). Also, this improvement can be associated with a number of factors, including the structural change of the economy after the 1994 elections, the opening up of trade, tax relief and the gradual decrease in interest rates during that period. In particular, if the TFP growth rates experienced since 1994 are sustained and labor market rigidities are eased sufficiently so that employment rises in step with future increases in the labor force and increases in fixed capital formation, then the economy could achieve growth rates of around 5% over the longer term (see [5]). [18] predicts that the average projected growth from 2007-2012 would be slightly lower than the potential growth, as the positive output gap closes over this period. This may be due to capacity constraints such as the emerging scarcity of energy, cement, electricity and steel. These sentiments are also endorsed by the SA National Treasury (see [18] for more details).

2. Cyclicality Defined

From [8] it follows that business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize 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. This sequence of changes is recurrent but not periodic. In duration, business cycles vary from more than one year to eight or ten years. Here an “expansion” is the period between a trough (lower reference turning point) and a peak (upper reference turning point) while a “recession” is the period between a peak and a trough. Cyclicality of a macroeconomic variable is related to its relationship with the business cycle or a proxy of the business cycle. In this regard, the direction in which a macroeconomic variable (such as production, expenditure, inflation etc.) moves is said to be procyclical if it tends to move in the same direction (up in expansions, down in contractions) as the business cycle. As such, procyclicality is an inherent property of any financial system. However, the concerns expressed by this paper are related to the occurrence of excessive (or strong) procyclicality that may have deleterious effects on the economy. On the other hand (see [1]), the movement of a macroeconomic variable is said to be countercyclical if it moves in the opposite direction (up in contractions, down in expansions) to reduce business cycle fluctuations. In addition, a financial variable is acyclical if there is no relationship with the business cycle. We note that, in the literature, alternative definitions for procyclicality and countercyclicity are also used. An economic variable is a leading variable if it tends to move in advance of the business cycle, and a coincident variable is one whose peaks and troughs occur at about the same time as the corresponding business cycle peaks and troughs. A lagging variable is one whose peaks and troughs tend to occur later than the corresponding peaks and troughs in the business cycle. In order for the aforementioned definition to be workable in the South African context, we need to identify the peaks and troughs. In order to achieve this, we make use of the methodology adopted in [24].

<table>
<thead>
<tr>
<th>Table 1: South African Lower and Upper Reference Turning Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trough (Lower Turning Point)</td>
</tr>
<tr>
<td>August 1992</td>
</tr>
<tr>
<td>November 1998</td>
</tr>
<tr>
<td>August 2001</td>
</tr>
<tr>
<td>June 2003</td>
</tr>
<tr>
<td>August 2007</td>
</tr>
<tr>
<td>August 2009</td>
</tr>
<tr>
<td>August 2010</td>
</tr>
<tr>
<td>July 2011</td>
</tr>
</tbody>
</table>

Source: [24].

3. Using Output Gaps as a Proxy for Business Cycles

Financial system instability can be identified via the output of an economy. This concept is related to the productivity of the economy and the quantity and quality of the various economic factors. In this regard, potential output is an indication of the aggregate supply capabilities of the economy and encapsulates information about movements in the stock of capital, labor and technical change. In principle, over the medium term, the growth rate of potential output provides a useful guide for the assessment of sustainable non-inflationary growth in output and employment. In short, measures of potential output are indicative of the output level that an economy can produce based on factors of production (labor and capital; see [14]) and the efficiency with which they are combined (known as total factor productivity (TFP)). Despite its seeming importance, potential
output is not well-defined in the literature. Here the output gap is defined as the difference between actual and potential output. In addition to the above definition, in this paragraph we consider the properties, problems and computation of the output gap. In a macroeconomic context, it is an indication of the level of prices and wages, and influences all key macroeconomic variables via the supply system. The output gap's main property is that it can be computed in real time as a proxy for the business cycle (which can only be determined in hindsight). Also, the output gap is an important input for monetary policy decisions, as it is reasonably correlated over time with inflation and capacity utilization. This utilization property implies that the output gap can be regarded as a good predictor of the booms and recessions consistency. It is for these three reasons that we study the output gap rather than the business cycle in this paper.

4. The Alternative Output Gap Estimation Techniques

Since the biggest problem with the output gap is that it is not directly observable and thus has to be estimated via potential output, we use several alternative methods rather than relying on any single technique. This is done by computing the potential output via production function approach, appropriate time series and the Hodrick-Prescott (HP) filter (see, for instance, [15]). The first method is a structural method and the latter two methods are statistical methods. Note that the estimates of potential output will change as the structure of the economy changes, and the results obtained using different methods may differ substantially (see [9]).

4.1 Time Series Model

Univariate time series models are used to model and to predict financial variables using only information contained in their own past values and possibly current and past values of an error term. These models attempt to capture empirically relevant features of the observed data that may have arisen from a variety of different structural models. The purpose of time series analysis is to capture and examine the dynamics of the data. Time series forecasting is usually done by exploiting the dynamic inter-relationship, which exists over time for any single variable. An important class of time series models is the AutoRegressive Integrated Moving Average (ARIMA) models (see [18]).

In this paper we capture the dynamics of the output gap data by means of an appropriate time-series model. This will be done by extracting as much information as possible from the past history of the output gap series and by using EVIEWS.

By applying the Augmented Dickey-Fuller (ADF) Unit Root Test on the first differenced data it follows that the time series is covariance stationary (i.e. the shocks are temporary; over time, the effects of the shocks will dissipate and the series will revert to its long-run mean level). This conclusion is based on the following result

\[ H_0 := \text{First difference data has a unit root} \]

\[ \text{ADF one-sided } p\text{-value } = 0.0012 \]

We used the Box-Jenkins approach in selecting an appropriate parsimonious ARIMA model. The ARIMA(1,1,1) model was the estimated model with the smallest Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) values. Our estimated ARIMA(1,1,1) model was of the following form:

\[
\begin{align*}
\Delta Data &= 2.025 + 0.586 \Delta Data_{t-1} + u_t - 0.935 u_{t-1} \\
AIC &= 6.88 \\
SBC &= 7.03
\end{align*}
\]

where the \( u_t \) are error terms. We know that if a model has been specified correctly, the residuals \( \tilde{u}_t \) should resemble a white noise process. Therefore, we check if the residuals \( \tilde{u}_t \) are nearly uncorrelated with each other. From the sample correlogram it follows that the ACFs of the sample residuals are close to 0 for lags \( k \geq 1 \) suggesting that the sample residuals are serially uncorrelated.

From Figure 2 it follows that usually the forecast is within 20 percent of the actual series. Therefore, the ARIMA(1,1,1) model captures the trends of the data but fails to predict sharp turns. Still this model would be quite acceptable as a forecasting tool.

4.2 Hodrick-Prescott Filter

The Hodrick-Prescott filter is a common univariate filtering technique to decompose a time series into a long-term trend and cyclical part. This technique rests upon a statistical detrending method and has no explicit economic foundation, but is widely used among macroeconomists. The method was first used by Hodrick and Prescott to analyze postwar U.S. business cycles (see [15]). The weakness of the Hodrick-Prescott filter is that the end points of the estimated trend output series tend to be sensitive to the last few observations in the sample.

The Hodrick-Prescott (HP) filter is a two-sided linear filter that computes the trend series \( \hat{t} \) of \( y \) by minimizing the variance of \( y \) around \( t \), subject to a penalty that constrains the second difference of \( t \), i.e., the HP filter chooses \( t \) to minimize:

\[
\sum_{i=1}^{T} (y_i - \hat{t}_i)^2 + \lambda \sum_{i=2}^{T-1} \left( t_{i+1} - t_i - (t_i - t_{i-1}) \right)^2
\]

The penalty parameter \( \lambda \) controls the smoothness of the series \( \sigma \). The larger the \( \lambda \), the smoother the \( \sigma \), \( t \) approaches a linear trend. Since we work with annual data, we choose \( \lambda = 100 \) in this article.
4.3 Production Function Approach

This method is based on estimated structural methods. We use the approach of [10] on the estimation of the potential output to estimate the potential output for South Africa for the period 1994-2011. The relationship between output and total factor productivity (TFP), capital and labor in the South African economy is described by the following Cobb-Douglas type production function

\[ Y_t = A_t K_t^\alpha N_t^\beta \]  

where

- \( Y_t \) = Actual GDP at factor cost
- \( A_t \) = Unobservable TFP
- \( K_t \) = Actual capital stock
- \( N_t \) = Actual employment

0 < \( \alpha < 1 \) and \( \beta = 1 - \alpha \).

By estimating the potential levels of all the variables on the right-hand side of Equation 2, the potential level of output can be determined. The potential output is given by the following equation:

\[ Y^*_t = A^*_t K^{*\alpha}_t N^{*\beta}_t \]  

where

- \( Y^*_t \) = Potential GDP at factor cost
- \( A^*_t \) = Potential TFP
- \( K^*_t \) = Potential capital stock
- \( N^*_t \) = Potential employment

0 < \( \alpha < 1 \) and \( \beta = 1 - \alpha \).

The level of unemployment and its associated non-accelerating interest rate of unemployment NAIRU are incorporated in the estimation of potential employment, i.e.

\[ N^* = EAP(1 - NAIRU) \]  
\[ EAP = \text{The economically active population} \]  
\[ NAIRU = U - \left( \frac{D[U]}{D^2[\ln(W)]} \right) D^2 \ln(W) \]  
\[ U = \text{Unemployment rate} \]  
\[ W = \text{Real wage rate} \]  
\[ D = \text{First difference operator.} \]

4.3.1 The South African Potential Employment

The terms supply of labor and the labor force are used as synonyms for the economically active population. Stats SA define the economically active population (EAP) as all persons between the ages of 15 and 65 years who are working, or are unemployed. The EAP include people employed in the formal sector and the self-employment, but exclude people of working age who are not economically active (NEA) such as full-time home makers, students, pupils, and those who are unable or unwilling to work. In the analysis of unemployment rates, it is important to make a distinction between the official definition of unemployment and the expanded definition of the unemployment. The official definition of unemployment includes those people within the economically active population who a) did not work during the seven days prior to the interview, b) want to work and are able to begin work within a week of the interview and c) have taken steps to look for employment or start some form of self-employment in the four weeks prior to the interview (see Stats SA). The expanded definition of unemployment on the other hand includes those people within the economically active population who a) did not work during the seven days prior to the interview and b) want to work and are able to begin work within a week of the interview. It also includes the discouraged job seekers (those who say they were unemployed but have not taken steps to find work in the four weeks prior to the interview) (see Stats SA). The expanded definition does not require a person to have actively sought employment in order to qualify as unemployed. It thus counted jobless people too “discouraged” to look for work as unemployed. The unemployment rate indicates the number of people unemployed as a percentage of the total economically active population (labour force). The official provincial unemployment rate according to these two definitions are summarized in Table 2 below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Official*</th>
<th>Expanded**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>14</td>
<td>31.5</td>
</tr>
<tr>
<td>1995</td>
<td>11.3</td>
<td>33.6</td>
</tr>
<tr>
<td>1996</td>
<td>13.6</td>
<td>35.6</td>
</tr>
<tr>
<td>1997</td>
<td>14.8</td>
<td>36.7</td>
</tr>
<tr>
<td>1998</td>
<td>20.4</td>
<td>37.9</td>
</tr>
<tr>
<td>1999</td>
<td>20</td>
<td>39.1</td>
</tr>
<tr>
<td>2000</td>
<td>26.7</td>
<td>40.5</td>
</tr>
<tr>
<td>2001</td>
<td>28.6</td>
<td>43.6</td>
</tr>
<tr>
<td>2002</td>
<td>29.7</td>
<td>45.2</td>
</tr>
<tr>
<td>2003</td>
<td>28.4</td>
<td>46.7</td>
</tr>
<tr>
<td>2004</td>
<td>28</td>
<td>46</td>
</tr>
<tr>
<td>2005</td>
<td>27.4</td>
<td>44.9</td>
</tr>
<tr>
<td>2006</td>
<td>25.6</td>
<td>39</td>
</tr>
<tr>
<td>2007</td>
<td>25.5</td>
<td>38.3</td>
</tr>
<tr>
<td>2008</td>
<td>30</td>
<td>35.1</td>
</tr>
<tr>
<td>2009</td>
<td>23.6</td>
<td>29.7</td>
</tr>
<tr>
<td>2010</td>
<td>25.2</td>
<td>32.5</td>
</tr>
<tr>
<td>2011</td>
<td>23.8</td>
<td>37</td>
</tr>
</tbody>
</table>

Source: * [23], 2012; ** Global Insight, 2006 and 2012

5. Numerical Example

In this subsection, we simulate the business cycle observations against the estimated output gap values for the respective models by using MATLAB. From Figure 1 it follows that the production function where the official unemployment data was used fit the business cycle data better.
than the production function where the expanded unemployment data was used. From Figure 3 it follows that the Hodric-Prescott filter reproduces some of the turning points. From the simulations it follows that the model that best fits the business cycle is the Hodric-Prescott filter.

Furthermore, we use a subsample of the output gap observations from 1990-2009 to estimate the respective models. We then compare the forecasts values of these models to the business cycle values for the period 2010-2011. Let $T = 22$ be the total sample size (in-sample + out-of-sample) and $T_1$ be the first out-of-sample forecast observation. First we calculate the mean absolute percent error (MAPE), i.e.

$$MAPE = 100 \times \frac{\sum_{i=T_1}^{T} |Data\ value - Model\ value|}{Data\ value \cdot T - (T_1 - 1)}.$$  \hspace{1cm} (5)

Another measure which also gives an estimate of the goodness or quality of fit is the root mean square error (RMSE) given by

$$RMSE = \sqrt{\frac{\sum_{i=T_1}^{T} (Data\ value - Model\ value)^2}{T - (T_1 - 1)}}.$$  \hspace{1cm} (6)

The smaller the error, the better the forecasting ability of that model according to this criterion. In Table 3 we give the relevant values of MAPE and RMSE.

<table>
<thead>
<tr>
<th>Model</th>
<th>MAPE(%)</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time series model</td>
<td>26.30191</td>
<td>3.30</td>
</tr>
<tr>
<td>Hodrick-Prescott filter</td>
<td>33.74</td>
<td>3.62</td>
</tr>
<tr>
<td>Production function approach</td>
<td>32.67</td>
<td>3.95</td>
</tr>
<tr>
<td>(Official unemployment rate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production function approach</td>
<td>33.06</td>
<td>3.93</td>
</tr>
<tr>
<td>(Expanded unemployment rate)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: South African business cycle and output gap using the production function approach

Figure 2: South African business cycle and the estimated values using the ARIMA(1,1,1) model

Figure 3: South African business cycle and output gap using the HP technique

Table 3: MAPE and RMSE for each estimation model
From Figure 2 and Table 3 it follows that the ARIMA(1,1,1) time series model gives the most realistic out-of-sample forecast for the business cycle values. The respective root mean square error and mean absolute percent error for the ARIMA(1,1,1) model is 3.30 and 26.30. However, we still observe a significant difference from the data values.

Note that the MAPE (%) decreases from 33.74% to 26.3% and the RMSE value decreases from 3.95 to 3.03 in the time series model.

6. Conclusion and Future Directions

We have compared the accuracy and efficiency of forecasts prepared by the Hodrick-Prescott filter, ARIMA(1,1,1) model and Production function. Our analysis shows that the set of forecast errors produced for the business cycle by the ARIMA(1,1,1) model was consistently smaller than that of the other two models.

In the future, we hope to form a better understanding of the interaction between the key macroeconomic variables and the business cycle. Since some economic variables consistently lead the business cycle, they might be used to forecast recessions.

References


[19] Organization for Economic Co-Operation and Development (OECD). Composite leading indicators for major OECD non-member economies (Brazil, China, India, Indonesia, Russian Federation and South Africa) and Recently New OECD Member Countries (Korea, New Zealand, Czech Republic, Hungary, Poland and Slovak Republic). March 2006.


