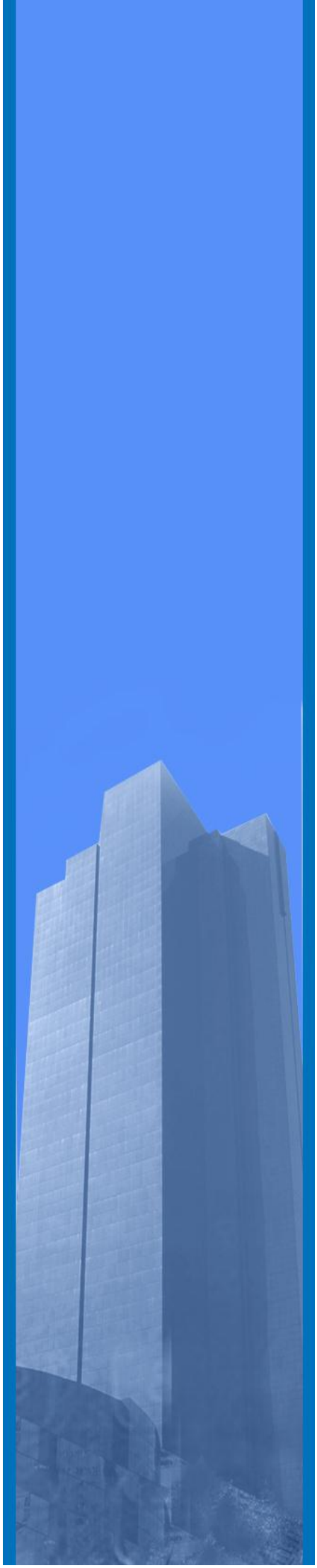

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The pace of potential output growth in the South African economy

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The pace of potential output growth in the South African economy

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Abstract

In a flexible inflation-targeting framework the output and inflation gaps are key measures of inflationary pressures and play an important role in determining the optimal policy interest rate. The estimation of potential output is, however, a challenge since it cannot be directly observed. This note explains the methodologies currently used by the South African Reserve Bank to estimate potential output growth and discusses changes to the estimate since the onset of the global financial and economic crisis.

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Keywords: HP filter, MV filter, potential output, production function

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[1] The authors would like to thank V Anvari and S de Jager for their valuable contributions.

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Abbreviations

EAP	economically active population
ECB	European Central Bank
GDP	gross domestic product
HP	Hodrick–Prescott [filter]
MPC	Monetary Policy Committee
MV HP	multivariate Hodrick–Prescott [filter]
NAWRU	non-accelerating wage rate of unemployment
PGDPM	Potential Gross Domestic Product Model
PGEM	Potential General Equilibrium Model
SARB	South African Reserve Bank
US	United States

1 Introduction

In a flexible inflation-targeting framework the output and inflation gaps are key measures of inflationary pressures and play an important role in determining the optimal policy interest rate. The estimation of potential output is, however, a challenge since it cannot be directly observed. This note explains the methodologies currently used by the South African Reserve Bank to estimate potential output growth and discusses changes to the estimate since the onset of the global financial and economic crisis.

While the historical inflation gap calculation is fairly simplistic (measured by the difference between the known inflation target and expected price inflation), the output gap is expressed as the deviation between the actual level of output and an estimate for the potential level of output of the economy. Potential output is not directly observable. The long-term trend in real output generally shifts upwards as more resources – primarily labour and capital – become available, and as technological progress allows more efficient use of existing resources. However, real output also displays a short-term variation around that long-term trend – largely because of the influence of the business cycle, but also because of severe shocks that may cause a more pronounced deterioration of factors of production and resource use. Depending on the extent of the shock, this can result in a temporary, albeit prolonged, deviation from its previous trend. Although potential output measures the productive capacity of the economy, it should not be viewed as a short-term technical ceiling on output that cannot be exceeded. Rather, it is a measure of sustainable output, in which the extent of resource use is not adding to, or subtracting from, inflationary pressure.

When forecasting, the challenge of the potential output calculation is amplified. Not only must the current potential output and the output gap be estimated, but the pace of the potential output growth needs to be assumed over the forecast horizon. When an economy is subjected to a serious and prolonged negative shock, such as the current global crisis, the factors of production may deteriorate well below their potential levels, causing the current potential output level to deviate substantially from its long-run trend.

This note provides estimates of the output gap by means of an aggregate measure for the level of potential output over the past few years.

2 Estimation techniques

The information content of observable macroeconomic data is central to the estimation of potential output and whether demand and supply shocks can be accurately identified. This involves exploiting statistical and/or structural approaches to separate temporary (demand) and permanent (supply) influences on output. Butler (1996) suggests a set of criteria to asses methods used to estimate potential output. These criteria include economic consistency; the ability to incorporate additional judgement flexibly; and the ability to reduce and quantify uncertainty about the current level of potential output and specification robustness. However, it should be noted that it is highly unlikely that one estimation method could be expected to match all of the listed criteria. For that reason, we set out single-method estimates and compare them to a separate measure that aggregates the estimates.

2.1 De-trending smoothing techniques

One class of techniques involves the application of simple de-trending (smoothing) techniques to actual developments in real gross domestic product (GDP). These de-trending methods are statistical and results are often referred to as ‘trend growth’ and the output gap as a ‘deviation from trend’. Usually when there is a significant change to the actual observed output, potential output is revised accordingly.

The widely used Hodrick–Prescott (HP) filter decomposes an observed shock into a supply and a demand component (Hodrick and Prescott 1980, 1997). This filter applies the distinction that supply shocks have permanent or lasting effects on output, while demand shocks are considered to be temporary. However, it is important to note that persistent demand shocks may have longer-term supply-side effects which the filter cannot distinguish. The choice of the degree of cycle versus trend to include in the estimation procedure (set by choosing a value for the

smoothing parameter, often referred to as the so-called lambda), is chosen subjectively and is often prone to debate.

2.2 Structural and semi structural techniques

2.2.1 Production function techniques

Another class of estimation technique incorporates structural information as set out in a typical production function specification. These measures of potential output integrate structural frameworks by including information concerning capital stock, working population, trend participation rates, structural unemployment and developments in factor productivity.

The SARB's Potential Gross Domestic Product Model (PGDPM) – a highly aggregated, small supply-side model – was used to estimate potential output. Here potential output is the level of output that results when the factors of production and total factor productivity are at their respective "potential" levels.[2] Any revision to potential output is then due to a change in the production factors listed above. Typically, a production function may be represented by the following expression:

$$Y_t = A_t K_t^{\alpha} N_t^{\beta} \quad (1)$$

where Y_t is actual GDP at factor cost; A_t is unobservable total factor productivity (TFP); K_t is the actual capital stock, and N_t is actual employment. α and β represent the capital and labour share parameters respectively, where constant returns to scale are assumed, that is, $\alpha + \beta = 1$.

The potential level of output is determined by estimating the potential levels of all the variables of equation 1. The superscript * is used to denote potential levels of all variables, and potential output Y^*_t is derived from:

$$Y^*_t = A_t^* K_t^{*\alpha} N_t^{*\beta} \quad (2)$$

The potential level of total factor productivity A^* is approximated using a Solow-residual approach, and a neoclassical (Jorgenson) approach is used to estimate the desired capital stock *K**. Specific attention is paid to the sustainability of non-inflationary growth associated with the labour market by utilising both actual rates and underlying natural rates of unemployment (i.e., the non-accelerating wage rate of unemployment, or NAWRU). The labour input is consequently adjusted for the gap between actual unemployment and the NAWRU to obtain *N**.[3]

This structural model, inclusive of the disaggregated capital stock channels, was simulated to determine the potential output for the South African economy, assuming some level of structural unemployment estimated to range between 25 and 28 per cent (using the expanded definition of unemployment). These structural unemployment numbers broadly correspond to those calculated by the Organisation for Economic Co-operation and Development (OECD 2010) in its economic survey of South Africa 2010/11 report (OECD 2010, 98).

2.2.2 Multivariate HP filter

The multivariate Hodrick–Prescott filter (MV HP filter) is a semi-structural approach that augments the statistical properties of the HP filter with structural relationships from an Okun's Law, Phillips curve and capacity utilisation relationships (see Conway and Hunt 1997).

The inclusion of a Phillips curve in this approach allows for the hypothesis that production constraints in the economy play a role in the inflation process and helps to separate out the different impact of supply and demand shocks on inflation. The equation is specified as follows:

$$\pi_t = \alpha_1 \pi^e_{t-1} + \alpha_2 (y_{t-2} - \varphi_{t-2}) + \alpha_3 (m_{t-1} - m_{t-3})/2 + \varepsilon_{\pi,t} \quad (3)$$

[2] See Box 2 in the SARB, *Monetary Policy Review* (Pretoria: SARB, May 2006). This is a model based on annual data. It is updated annually and the potential output is then re-estimated.

[3] The potential level of employment is defined as the level of labour resources that might be employed without resulting in additional inflation, assuming some natural rate of unemployment (NAWRU). According to this definition, potential employment (*N**) is the difference between the economically active population (EAP) and the fraction of EAP that is naturally unemployed, that is, *N*=EAP(1-NAWRU)*.

In equation 3 the variables π_t, π_t^e, y_t, Φ_t and m_t represent consumer inflation, consumer inflation expectations, the log of actual real output, the log of potential output and the log of nominal effective exchange rate at time *t*. The residual term is represented by $\varepsilon_{\pi t}$. Backward-indexed consumer inflation expectations are assumed in this equation and the nominal effective exchange rate is included to reflect the impact of imported prices on domestic prices.

Okun's Law represents the relationship between the disequilibria in the goods and labour markets. According to equation 4, this relationship allows a fall in actual unemployment to a level below its trend, to be interpreted as a positive shock to the output gap.

$$U_t - U_{p,t} = \delta(y_t - \varphi_t) + \varepsilon_{U,t} \qquad (4)$$

In this equation, U_t is the unemployment rate[4], U_{pt} is trend unemployment (measured by an HP filter) and the residual term is represented by ε_{Ut}, at time t.

The utilisation of productive capacity in the economy is also used as a condition in the multivariate filter, specifically in terms of the deviation of capacity utilisation from its longer-term trend. The intuition being that when capacity utilisation exceeds its longer-term trend it indicates a positive shock to the output gap.

$$C_t - C_{p,t} = \gamma(y_t - \varphi_t) + \varepsilon_{C,t} \qquad (5)$$

In equation 5, C_t represents capacity utilisation in the manufacturing sector and C_{pt} is its trend, proxied by an HP filter, at time t. Deviations of capacity utilisation from its

[4] The unemployment rate was compiled by incorporating evidence from the October Household Surveys, the mid-year population estimates, the Surveys of Total Employment and Earnings, the Quarterly Employment Surveys and the Labour Force Surveys as published by Statistics South Africa. The unemployment series is therefore calculated as the difference between the economically active population and employment.

trend transfer onto the same change in the output gap, since the parameter γ is set equal to one.

The HP filter methodology is augmented by incorporating these structural equations as restrictions in the optimisation procedure. The extent to which the estimate of potential output is influenced by the structural equations is conditioned by weighting each of the residual error terms. The well-known smoothing parameter lambda (λ) is specified as a time series so that the smoothing characteristics of the filter can be altered through time if deemed necessary. To avoid circularity, the procedure of optimisation requires an inter-temporal iterative process that is repeated until the changes between iterations satisfy some pre-specified convergence criteria.

2.2.3 General equilibrium approaches

General equilibrium approaches are increasingly used to estimate potential output. The SARB's Potential General Equilibrium Model (PGEM)[5] makes use of a general equilibrium approach to modelling the potential output level of the South African economy. The PGEM is a "gap model" and incorporates actual output, inflation (both actual and expected), unemployment and capacity utilisation data in an effort to estimate the unobservable potential output using a multivariate Kalman filter. Specifically, each of the four key variables has an implied equilibrium or steady state level, and actual deviations from these levels are considered gaps. The SARB model is augmented with a global component, which allows changes to global potential growth to alter South Africa's own potential growth rate.

One way of moderating biases associated with each estimation technique is to aggregate the different techniques to create an additional estimate of South Africa's potential output and the extent of the output gap.

[5] This model is based on a core structure of a model that was first developed by the International Monetary Fund, which uses a Kalman filter to estimate potential output on economic relationships and observable data, with some adaptations by the SARB to reflect South African conditions.

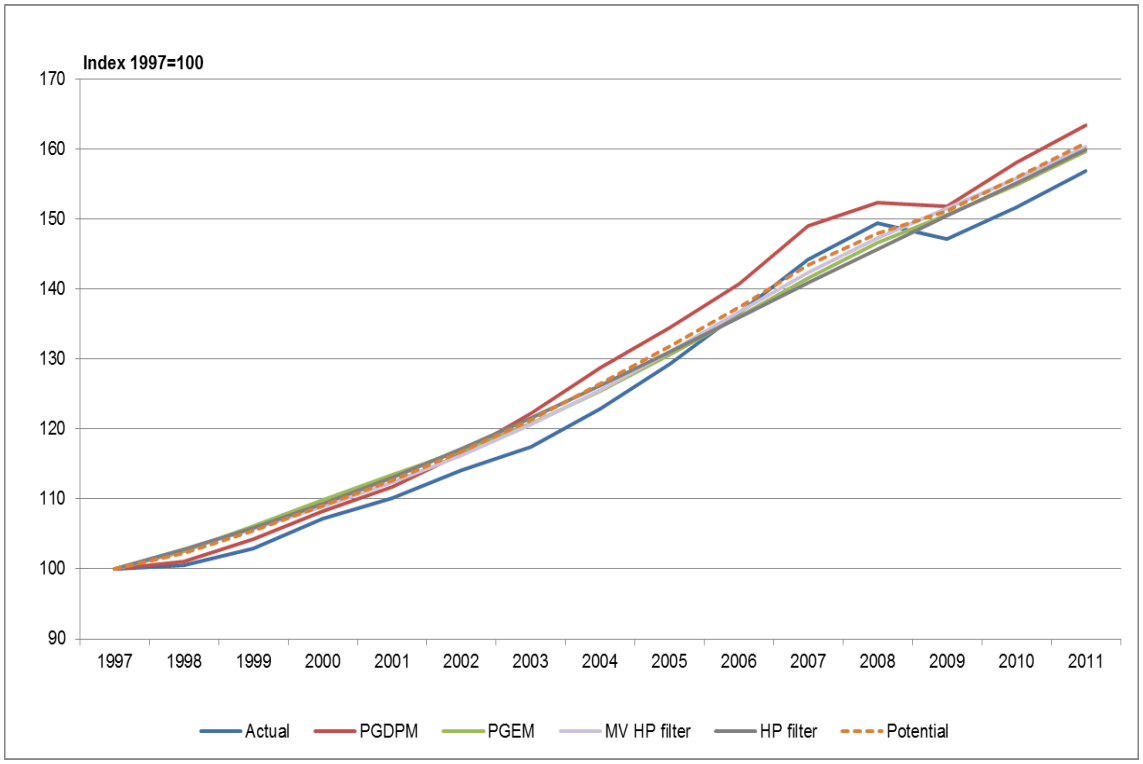
3 Estimates of potential output

Since the global financial crisis, the global and domestic economic recoveries have been longer than previously anticipated. This slower pace has prompted a reassessment of potential output growth used in the SARB suite of models.

Figure 1 shows the level of actual and potential output as calculated by the various techniques described above, and the combined average. The figure illustrates that there is no material difference between the various smoothing methodologies and the PGEM model, as the lines are in close proximity to one another. The level of potential output as calculated by the PGDPM (production function) more or less tracks the trajectory of actual output, but appears to be on a higher level, in part influenced by the magnitude of full employment, adjusted for natural unemployment. The other estimates employ smoothing mechanisms, to different degrees, rendering these to be less volatile measures of potential output.

The impact of the 2008/09 slowdown is visible in the level of actual output (blue line), and it is important to note that actual output has remained below every measure of potential output since 2009. The measure of potential output used in further references is calculated from the aggregate of the various methodologies using equal weights (the dotted line in Figure 1).

Figure 1: Actual and potential output level

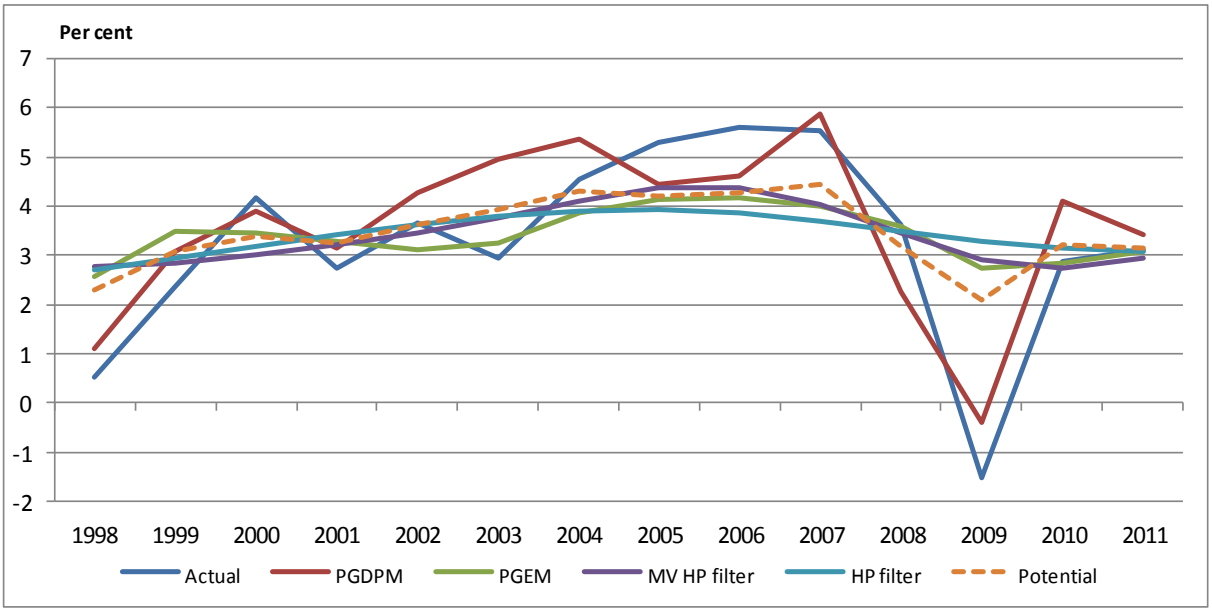


PGDPM = Potential General Equilibrium Model; PGEM = Potential General Equilibrium Model; MV HP = multivariate Hodrick–Prescott; HP = Hodrick–Prescott

By their nature, the annual growth rates in potential output (see Figure 2) as estimated through the various de-trending techniques exhibit a smoother profile than that arrived at by using the PGDPM supply-side technique and do not fluctuate as much. Nevertheless, all the methodologies show a slowdown in potential growth rates from 2007. The results obtained from the PGDPM technique display a more pronounced decline in 2008 (as employment and productivity contributions decline sharply), before recovering to more or less the same level as those of the de-trended filters. By using an average, the extremes are "smoothed" so that the eventual result is not as volatile as would be the case if only the supply-side model were used. At the same time, they are not so stable that deep economic shocks are diluted by the de-trending methods.

These variations in the aggregate potential output raise questions about the characteristics of the long-run level, the pace of potential output and the magnitude of the output gap. When estimating the pace of potential output, we calculate an average over a period that covers the full business cycle, and not by merely taking the latest reading.

Figure 2: Actual and potential output growth (per cent)



PGDPM = Potential General Equilibrium Model; PGEM = Potential General Equilibrium Model; MV HP = multivariate Hodrick–Prescott; HP = Hodrick–Prescott

Table 1 summarises the estimates of the long-run potential growth rate of the South African economy over various time periods. For purposes of comparison, the results from the various techniques are also shown, together with the potential output as calibrated from the different techniques (last column in Table 1).

Table 1: South Africa's actual and potential output (per cent)

Period	Actual output	Methodology				Potential (average of methods)		
		HP filter	MV HP filter	PGEM	PGDPM			
1998–2008	3,7	3,5	3,6	3,5	3,9	3,6		
1998–2011	3,2	3,4	3,4	3,4	3,6	3,5		
Calculated over a period comparable to the ECB study: South Africa							**Euro area**	**US**
2000–07	4,3	3,7	3,8	3,7	4,6	3,9	1,9	2,5
2008–10	1,7	3,3	3,0	3,1	2,0	2,8	0,9	1,8

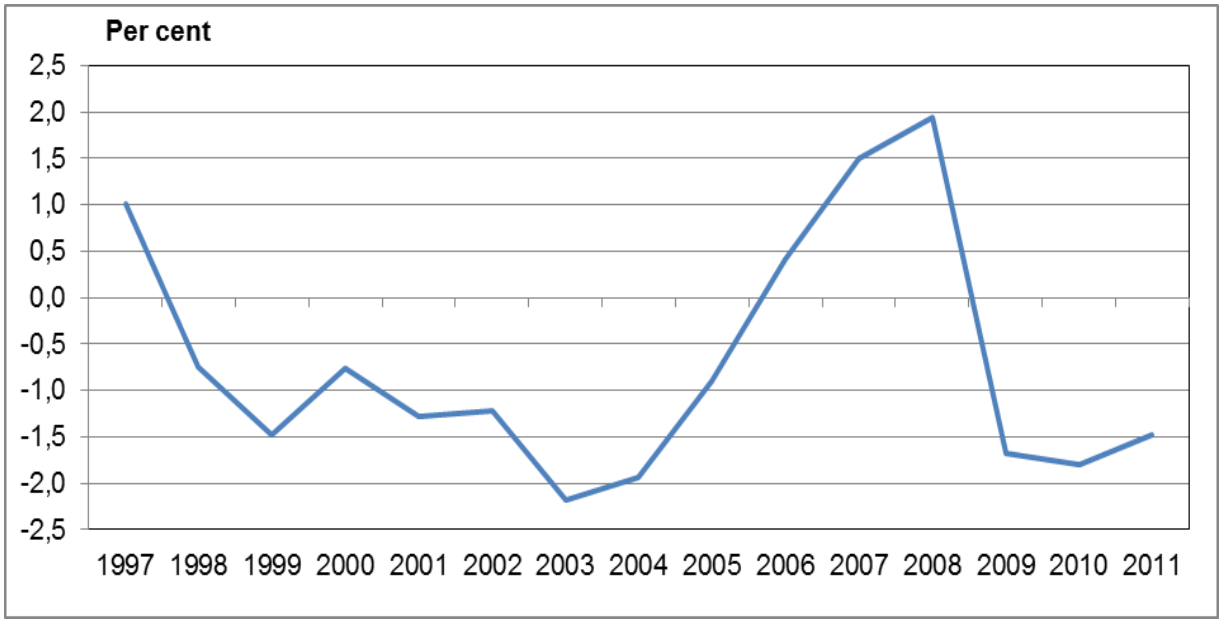
ECB = European Central Bank; PGDPM = Potential General Equilibrium Model; PGEM = Potential General Equilibrium Model; MV HP = multivariate Hodrick–Prescott; HP = Hodrick–Prescott

The SARB latest estimate of annual long-run potential output growth is 3,5 per cent. Notably, over the longer horizon of 1998–2011 (the latest full set of annual data ends in 2011) the average estimates from the different techniques do not differ materially. The average deceleration of potential GDP from 1998 to 2008 and from 2009 to 2011 was caused by the deterioration in the contribution by labour and total factor productivity, which was not fully offset by the improvements in the contribution of the capital stock.

Our estimates for South Africa (see Table 1) over the same period as the ECB study reflect a decline from an average of 3,9 per cent to 2,8 per cent; more or less similar to the estimated magnitude of decline in the euro area and the United States. The European Central Bank (ECB) has noted in a study that the financial crisis could have a longer-term impact on potential output for a number of years to come as the factors of production were severely affected by the crisis (ECB 2011, 75). According to the ECB study, euro area potential growth decelerated from an average of around 1,9 per cent over the period 2000–07 to an average of 0,9 per cent over the period 2008–10. A similar decline in potential output growth is quoted for the US economy over these two periods at 2,5 per cent to 1,8 per cent. The study explains that for the euro area the decline is attributable to lower contributions from labour and capital inputs, while the total factor productivity contribution changed only marginally.

A change in the trajectory of potential output will impact both the magnitude of the output gap and the optimal interest rate path as indicated by a Taylor-type monetary policy reaction function. Figure 3 shows the trend of the output gap level estimate resulting from the equally weighted average of the different techniques explained to calculate the potential output. This graph illustrates that the negative output gap from 2009 to 2011 is roughly between 1,5 per cent and 2,0 per cent.

Figure 3: Output gap level



As the economy recovers and factors of production gradually expand, the estimate of long-run potential output growth will rise relative to current estimate. However, such a revision can only be ascertained by the evidence from forthcoming data. It should also be noted that in order to close the output gap, actual output growth must exceed potential output growth for a period.

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