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A semi-structural approach to estimate South Africa's potential output

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Non-technical summary

The potential growth rate and related output gap forms an integral part of the price formation process in the South African economy. The output gap in particular reflects the degree to which activities and processes in the economy are under pressure from excessive demand and thus generating inflation, or alternatively, under-performing and thereby pointing to reduced inflationary pressures. However, an economy's production potential cannot be observed directly and needs to be estimated.

A widespread divergence exists in the preferred model for the estimation of potential output growth. Due to the numerous limitations associated with statistical methods of estimating potential output, and in light of new research improving structural models, this paper proposes a move away from the conventional aggregation approach (see Ehlers, 2013), in favour of a single semi-structural model. This new measure reflects advances made by the Bank for International Settlements (Borio et al., 2013) by accounting for the impact of the financial cycle on real economic activity. In addition, building on findings by the International Monetary Fund (Beneš et al., 2010), the new measure of potential output introduces further economic structure via the relationship between potential output and capacity utilization in the manufacturing sector. Given these enhancements, the new measure is able to replicate the fundamental properties of purely statistical filters without any of the inherent shortcomings thereof.

The resulting estimates are more robust and less susceptible to historical revision and reflect an extensive consensus that potential output growth has been markedly lower since the onset of the financial crisis (mirroring most estimates of potential output growth internationally). Consequently, it is estimated that South Africa's potential growth rate has declined from 4.0 per cent in 2007 to 2.5 per cent in 2013.

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Abstract

The impact of the global financial crisis on estimates of potential output, and specifically the usefulness of accounting for financial effects in the estimation process, deserves special consideration. In this paper possible paths that potential output may follow after the financial crisis are discussed and a finance-neutral potential output measure is proposed. This approach incorporates information from financial indicators in the cycle of economic activity and it is shown that when financial shocks are controlled for, the level of potential output is lower in the build-up to the financial crisis and thereafter. When compared to other frequently used methods to estimate potential output, this approach appears to deliver more reliable estimates of the output gap, particularly in real-time.

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1 Introduction

It is convention in economic literature to view real economic growth in excess of potential output growth as a source of inflationary pressure. Therefore, the potential growth rate is considered to be the rate beyond which such growth will face production capacity constraints and hence deliver price increases.[1] However, an economy's production potential cannot be observed directly and needs to be estimated, accompanied by a degree of uncertainty. This estimation essentially involves the decomposition of real GDP in terms of a trend and a cycle. This trend in GDP is assumed to represent the economy's level of potential output, while the cycle that remains after the trend has been removed reflects the output gap.

The output gap – proxied by the difference between real GDP and the economy's non-inflationary production potential – serves as an indicator of inflationary pressures. It indicates whether activities and processes in the economy are under pressure from excessive demand and thus generating inflation, or alternatively, under-performing and thereby indicating reduced inflationary pressures. Although a substantial body of literature investigates the various methods to estimate potential output, most methods have deficiencies. As a result, the estimation of unobservable potential output remains an inexhaustible area of research.

The aftermath of the global financial crisis has renewed interest in the topic of potential output estimation, specifically whether the crisis has had a permanent effect on both the *level* of potential and the *growth rate* thereof. Preliminary evidence suggests that the crisis has permanently reduced the level of potential output in a number of developed economies, according to Benati (2012) and Furceri and Mourougane (2012), amongst others. However, whether the crisis has permanently lowered long-run potential growth rates remains unclear.

Often purely statistical filtering methods such as the Hodrick and Prescott (1997, hereafter HP) filter are used to estimate potential output. Devoid of any structural economic information, the HP filter decomposes the level of GDP into a trend (potential) and a cycle (gap), based on a smoothing parameter which determines the extent to which the trend may fluctuate. The ease of its application is the reason for its popularity. However, over the past decade – specifically following the global financial crisis – researchers have explored semi-structural approaches that incorporate economic information in a statistical procedure to estimate potential output. Beneš et al. (2010) serves as an example of the structural approach to estimating potential output where a statistical filter is augmented with economic concepts such as a Phillips curve, an Okun's law relationship and capacity utilisation.

More recently, Borio, Disyatat, and Juselius (2013, 2014) at the Bank of International Settlements (BIS) estimate potential output by incorporating financial cycle characteristics into the estimation procedure. Essentially, economic activity during boom phases of the business cycle is often driven by rapid credit extension and rising asset prices, and hence, these series contain valuable information about the actual magnitude of the cycle (or output gap) and the level of potential output. Although the measurement of unobservable variables such as potential output (and therefore output gaps) remains imprecise, Borio et al. show that the inclusion of financial indicators into the estimation procedure does improve the reliability of real-time output gap estimates, i.e. estimations that are based on unrevised data.

[1]This point of view is different to the other less frequently used interpretation of potential output being the absolute maximum growth that an economy is able to achieve.

2 The effects of the financial crisis on potential output

The financial crisis and the general moderation in global growth thereafter, has reduced potential growth rates in many countries and have adversely affected their levels of potential output (see Furceri and Mourougane, 2012). What is of importance, is whether the loss in the level, or both the level and the growth rate of potential output, is permanent or temporary.

Figure 1: Three possible effects of the crisis: changes to the level or growth rate of potential output

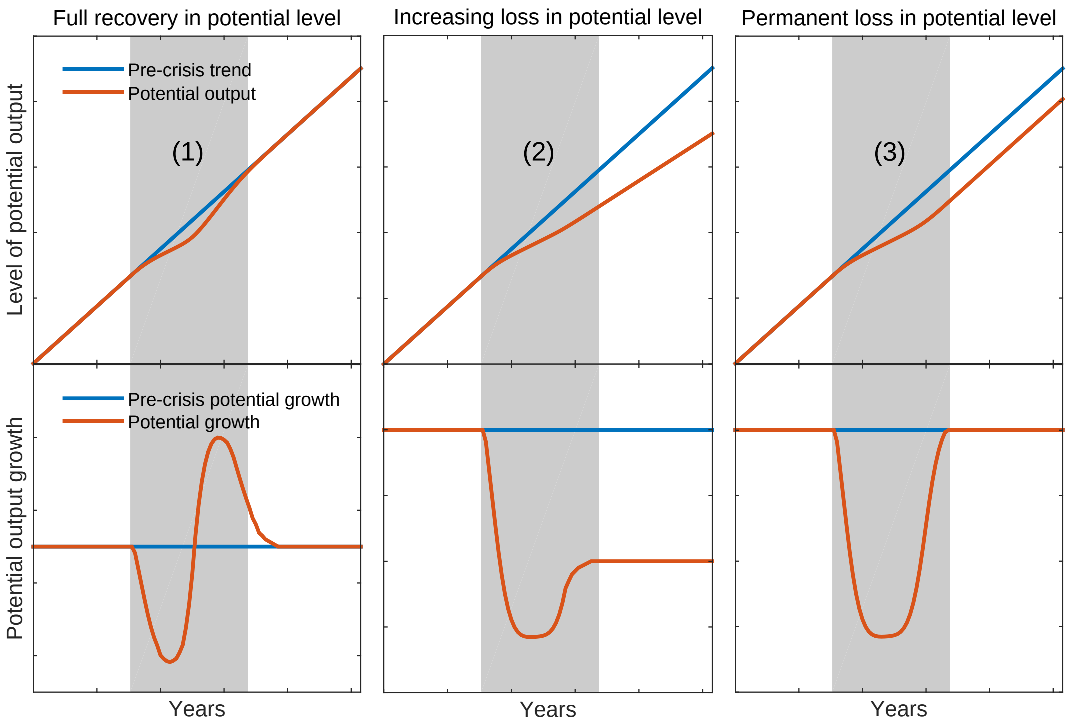
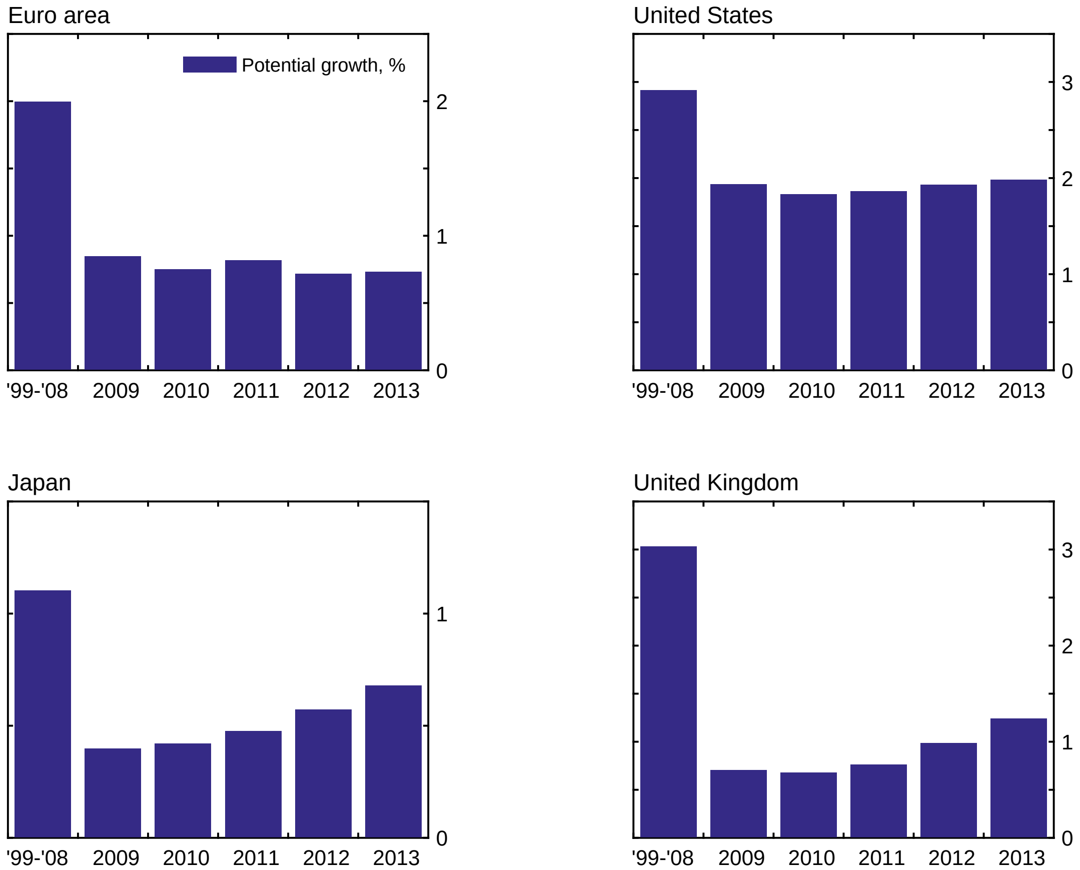


Figure 1 highlights three possible outcomes. In all of them, it is assumed that medium-term potential growth rates match their long-term counterparts before the crisis occurs. In the first outcome, the slowdown in potential growth causes the level of potential output to fall from its pre-crisis trend. However, the slowdown in potential growth is only temporary. In fact, during the recovery phase, potential growth rates temporarily accelerate to rates that exceed their long-term average. As such, the level of potential output returns to its pre-crisis trend. However this is a very optimistic outcome, and given the evidence to date it is unlikely that it describes the dynamics of potential growth over the last five years. In the second outcome, the hysteresis effects of the crisis cause potential growth rates to slow down permanently, as they do not recover to their pre-crisis rates of growth. As time progresses, the permanent decline in potential growth leads to a diverging loss in the level of potential output. This is the most pessimistic outcome. Finally, the third outcome sees a medium-term decline in potential growth rates, before they recover to their long-term rates of growth. This implies that the level of potential output increases at the same trajectory as before the crisis, but at a lower level – representing a permanent but constant loss in the level potential of output.

2.1 The international experience

In an attempt to determine the long-term effect of the global financial crisis on the *level* of potential output, Ball (2014) considers the loss in potential output growth rates for 23 countries by comparing current estimates with those that could have been attained in the absence of the financial crisis. The average weighted loss for the 23 countries is estimated to be 8,4 per cent.

Figure 2: Potential growth in OECD economies estimated to be lower since the global financial crisis



Source: OECD Economic Outlook, May 2014.

Figure 2 highlights these potential growth estimates and it is evident that growth in potential output is estimated to be markedly lower since the onset of the global financial crisis. In fact, when compared to its pre-crisis trend, Ball (2014) finds that the resultant loss in the *level* of potential output by 2013 in the Euro area, United States, Japan and the United Kingdom amounts to 8.8, 4.7, 8.5 and 11.0 per cent, respectively.[2] Although Johansson et al. (2013) is of the view that these losses in the level of potential output are permanent, it is too early to determine whether potential *growth* rates have also been permanently damaged, as illustrated in outcome (2) of Figure 1, or whether these will recover to their pre-crisis rates of growth, as portrayed by outcome (3).

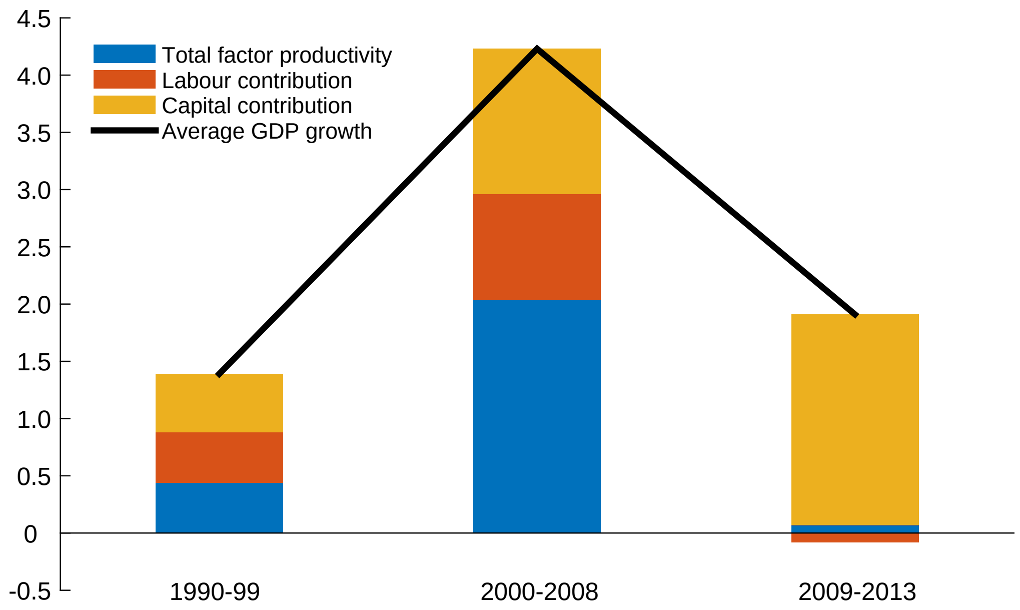
[2]The Euro area loss is calculated as a weighted average of the potential output loss of Euro-area OECD member countries.

2.2 The South African experience

Growth accounting assist in analysing the relative contributions of production factors and their effective to contributions to output growth. In Table 1, growth in South African real GDP from 1990 to 2013 is decomposed in terms of the relative contributions from total factor productivity (TFP), labour and capital.[3] The data is analysed across three key sub-samples. Firstly, the transition to democracy in the 1990s, followed by the advent of inflation targeting in 2000 and the eventual build-up to the global financial crisis in 2008, and finally, the aftermath of the global financial crisis from 2009 to 2013.

Table 1: Growth accounting suggests potential growth could be temporarily lower

		Contributions		
	Average GDP growth	TFP	Labour	Capital
1990-1999	1.4	0.4	0.4	0.5
2000-2008	4.2	2.0	0.9	1.3
2009-2013	1.9	0.2	-0.1	1.8



During the 1990s, observed real GDP growth averaged 1.4 per cent per annum, and was largely driven by equal relative contributions from labour, capital and TFP. From 2000 to 2008, real GDP growth accelerated to an annual average of 4.2 per cent. This increase in growth was characterised by a substantial increase in TFP, which accounted for almost half of the real GDP growth over this period. In addition, the average relative contribution of capital to real GDP growth increased from 0.5 per cent in the 1990s to 1.3 per cent from 2000 to 2008 – commensurate with the ratio of gross fixed capital formation to GDP which increased from 16.3 per cent in the 1990s to an average of 17.1 per cent

[3] For the decomposition of real GDP growth into the relative contributions of factor inputs, a constant returns to scale Cobb-Douglas production function is assumed. The labour share parameter in the Cobb-Douglas production function is calibrated to labour's share in national income, while the capital share is the inverse of the labour share. TFP is estimated as a Solow-residual (Solow, 1955).

over the period 2000 to 2008. Similarly, the contribution from labour to real GDP growth improved between the two periods (although its relative contribution declined).

The analysis suggests that South Africa's growth potential expanded during the first eight years of the 21st century. Nevertheless, beyond the global financial crisis of 2008, growth accounting points to lower potential growth rates. When compared to the preceding period, average annual real GDP growth decelerated from 4.2 per cent to 1.9 per cent. This slowdown in growth appears to have chiefly been driven by a fall in TFP and declining labour demand, which in turn affected the employability of those not employed and hence affects labour supply. This experience is in line with most global economies where hampered growth and tight credit environments hindered the scope for businesses to invest in new ventures or even to replace existing equipment. Furthermore, the ability to spend on research and development to enhance productivity was also severely curtailed.

According to Furceri and Mourougane (2012) a financial crisis can reduce potential output by between 1.5 and 2.4 per cent and they explain that this impact is largely related to the contribution of capital accumulation to output. On the contrary, in South Africa the contribution of capital accumulation to real GDP growth increased, as reflected by the increase in the ratio of gross fixed capital formation to GDP from 17.1 per cent preceding the crisis to 19.6 per cent during its aftermath. Although the declining contributions from TFP and labour suggest that South African potential growth is lower after the financial crisis than it was before, the fact that capital accumulation – a key driver of long-run economic growth – maintained its momentum in the wake of the crisis, indicates that the slowdown in the rate of potential growth is likely temporary[4]. Hence, the growth accounting exercise suggests that outcome (3) in Figure 1 could be the most likely scenario in the South African context.

3 Existing methods to estimate potential output

3.1 The Hodrick-Prescott filter

Given its simplicity and ease of use, the conventional starting point for determining potential output, and hence the output gap, is the HP filter. In essence the HP filter disaggregates the trajectory of a time series into two components: a long-run trend and a short-run cycle. It does so by minimising the following loss function:

$$L = \sum_{t=1}^{s} (y_t - y_t^T)^2 + \lambda \sum_{t=2}^{s-1} \left[(y_{t+1}^T - y_t^T) - (y_t^T - y_{t-1}^T) \right]^2 \tag{1}$$

When Equation (1) is applied to real GDP data (y_t), the resulting trend (y_t^T) is used as a proxy for potential output. The cycle that remains after the trend is removed ($y_t - y_t^T$), yields the output gap. However, statistical methods such as the HP filter have several well documented weaknesses. The foremost of these is that the filter requires a user-imposed smoothing parameter (λ) in order to inform the disaggregation. The value of λ determines the extent to which the trend (and hence the level of potential output) may fluctuate over time. By extension, this parameter also influences the length of the inferred business cycle. Hodrick and Prescott proposed a λ of 1600 for quarterly data, however this proposed value was both country and sample specific – it was based on their analysis of post-war

[4]Bond et al. (2010) provides empirical evidence of the relationship between capital accumulation and long-run GDP growth in a large sample of countries.

US data up to the late 1970s. The fact that this number has been commonly cited and utilised by most economists does not necessarily make it appropriate for potential output estimation of other countries, particularly countries that are expected to have a very high or very low persistence over the business cycle relative to the US (see Marcet and Ravn (2004)).

Aside from the fact that the standard HP filter doesn't incorporate any economic structure, the filter suffers from another significant flaw: it yields a path for the trend that tends to converge towards the actual data at the end points of the estimation sample, especially in times of stable GDP growth. This implies that the difference between the estimated level of potential output and the actual value of GDP is often biased toward indicating a *closed* output gap at the end of the sample. This weakness of the HP filter is commonly referred to as the "end-point problem". While there are a couple of proposed approaches that attempt to mitigate this problem, such as extending the sample with forecasts of GDP, none are capable of entirely eradicating it.

As time progresses and more data becomes available, the severity of the end-point problem becomes more apparent. Given the bias towards a closed output gap at the end point of the sample, the estimate of the level of potential output at a recent point in the sample gets revised by the filter as that period moves further into history and away from the end point. This feature causes revisions to the recent history of potential output and therefore the output gap. These revisions are often fairly substantial. As a result of this large historical revision variance, the most recent estimate of the output gap from a HP filter must be treated as a "soft" number that will most likely be subject to revision. The extent of this problem is succinctly demonstrated in Figure 3, where recursive estimates of the output gap are made using only the historical data available at each point in time.

Figure 3: HP filter output gap – revisions to real-time estimates

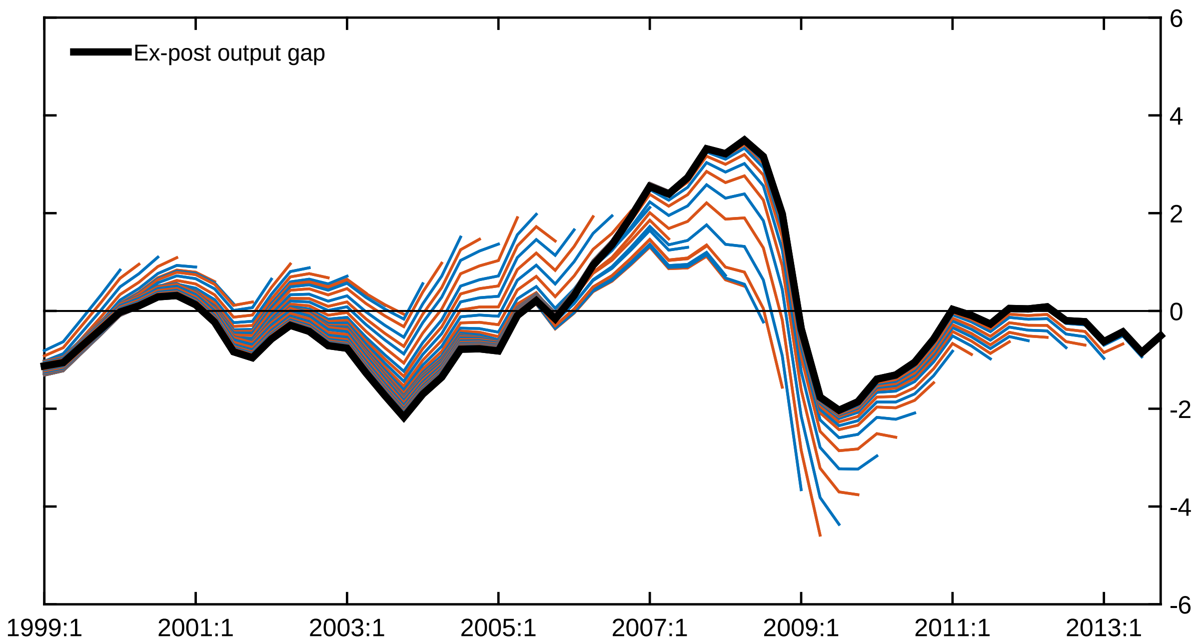


Figure 3 suggests that HP filter estimates of the output gap can only be considered reliable once a data point is a few years old. From a policy-making perspective, the practical implication of the end-point problem creates a dilemma: policy decisions are based in part on a real-time output gap estimate (and forecasts of the output gap which are highly dependant on the starting point) which could potentially be misleading should an HP filter estimate be used.

3.2 The production function approach

Similar to the growth accounting analysis in Section 2.2, a production function methodology disaggregates real GDP in terms of the factors of production; namely labour, capital and total factor productivity. However, whereas the actual levels of these inputs are used to do the growth accounting analysis, their "potential" levels are used to determine potential output in the production function approach:

$$Y_t^* = A_t^* L_t^{*\alpha} K_t^{*1-\alpha}, \tag{2}$$

where Y_t^*, A_t^*, L_t^* and K_t^* respectively denote the potential levels of output, TFP, labour and capital, while α denotes the labour share in output.

Apart from the fact that Equation (2) is a non-exhaustive representation of production, the estimate of the level of potential output now depends on *estimates* of the levels of potential labour, potential capital and TFP. Moreover, these estimates are fraught with challenges of their own. For example, the potential labour input is generally defined as the level of labour resources that could be employed, assuming some natural rate of unemployment.[5] In turn, this natural rate of unemployment is usually determined by means of an HP filter, opening up this methodology to the challenges discussed in the previous section. Similarly, the potential level of capital is mostly represented by an estimate of the *desired* capital stock and, determining the desired capital stock usually requires an assumption about the implicit rental rate of capital. Hence, these issues related to the estimation of the potential levels of the factor inputs all compound into uncertainty surrounding the eventual estimate of potential output.

3.3 System estimates

System estimates of potential output start off where the HP filter falls short: the lack of additional information regarding economic structure. In these system methods, theory-based relationships between the output gap, unemployment, inflation and capacity utilisation are specified, and then solved jointly to estimate the unobservable level of potential output. A recent example of such a system-based approach is Beneš et al. (2010). Essentially, the authors combine three key equations: Firstly, a Phillips curve that links inflation π_t to the output gap $y_t - y_t^T$; secondly, Okun's law, that links unemployment u_t to the output gap; and finally, an equation which specifies that capacity utilisation too depends on the output gap:

$$\pi_t = f\left(y_t - y_t^T\right) \tag{3}$$
$$u_t = f\left(y_t - y_t^T\right) \tag{4}$$
$$\textit{capacity utilisation}_t = f\left(y_t - y_t^T\right) \tag{5}$$

[5] A caveat of the potential level of employment is that it represents a production ceiling, rather than a non-inflationary level of employment. This suggests that the resulting potential output estimates could be biased upwards.

Given the economic structure of this system of equations, as well as actual data for output, inflation, unemployment and capacity utilisation, it is then fairly simple to filter out the potential output y_t^T implied by Equations (3) to (5). Beneš et al. (2010) find that adding additional information about the structure of the economy improves the revision variance of potential output estimates, when compared to that of the HP filter.

3.4 Aggregation approach

Given the various strengths and weaknesses of the individual approaches outlined above, it has become international best practice in policy institutions to utilise composite measures. The appeal of an aggregation approach is rather broad, but is centered around the fact that an average of several methods, each with its own shortcomings, is likely to be more accurate than any individual method. One such composite measure for the South African economy was proposed by Ehlers et al. (2013) who calculated potential GDP growth as an average of four variants of the methodologies discussed above.

4 A new measure of potential output[6]

The build-up to the global financial crisis was largely fuelled by excessive growth in asset prices, such as real estate, and the accompanying growth in credit extension. Similarly, the collapse in economic activity during the crisis occurred when asset prices fell and credit growth slowed. It is therefore evident that these financial factors point to a likely build-up of imbalances and therefore contain valuable information about the cycle of economic activity. This suggests that methodologies that do not account for financial data may provide distorted estimates of potential output. Such sentiments are echoed by two recent studies by Borio et al. (2013, 2014) at the BIS, which find that the inclusion of information about financial developments – such as growth in credit and house prices – improves both the accuracy and real-time reliability of estimates of potential output.

In order to estimate this "finance neutral" potential output, Borio et al. (2013) transform the minimisation problem utilised by the HP filter in Equation (1) into a state space system of equations and solve it using the Kalman filter. Essentially this setup involves two equations. The first equation produces an estimate of the unobservable variable – potential GDP – and is informed by a second equation which is based on observable data, such as actual GDP. As such, the equation for the *unobservable* level of potential GDP (y_t^T) is given as:

$$\Delta y_t^T = \Delta y_{t-1}^T + \epsilon_{0,t}, \tag{6}$$

where the residual $\epsilon_{0,t} \sim N(0, \sigma_0^2)$. Secondly, the measurement equation of *observable* variables is given as:

$$y_t - y_t^T = \gamma \mathbf{X}_t + \epsilon_{1,t}, \tag{7}$$

where y_t is actual GDP, $y_t - y_t^T$ is the output gap, $\mathbf{X}_t$ contains additional explanatory variables, and γ contains the parameters for each of the explanatory variables in $\mathbf{X}_t$. Similar to Equation (6), the residual $\epsilon_{1,t}$ follows a normal distribution with zero mean and variance σ_1^2. The equivalence between the HP filter and Kalman filter specification becomes apparent in the special case where $\gamma = 0$ and

[6] The authors are grateful towards Mikael Juselius at the BIS for his valuable assistance.

$\lambda = \sigma_1^2/\sigma_0^2$, as the Kalman filter specification above would then yield an estimate for potential GDP identical to the HP filter in Equation (1).

4.1 Estimation

When applying the Kalman filter setup in Equations (6) and (7) to the South African economy, four explanatory variables were considered:

$$\mathbf{X}_t = \left[output\ gap_{t-1},\ \Delta(credit_t),\ capacity\ utilisation_t,\ \Delta(house\ prices_t) \right]' \tag{8}$$

Firstly, the inclusion of the lagged output gap is aimed at capturing the substantial degree of persistence that is generally observed in output gap estimates. Furthermore, growth in credit and house prices – motivated by Borio et al. (2013) – are key to the purpose of this study: accounting for the impact of financial indicators on potential output. Finally, capacity utilisation in the manufacturing industry is included, as the relationship between potential output and capacity utilization is fairly intuitive and well documented (see, for example, Beneš et al., 2010).

The expansion of capacity in the manufacturing sector can be assumed to be a function of growth in potential output, whilst the actual utilisation of capacity points to the degree of excess (or lack of) demand in the economy, *i.e.* the output gap. This implies that when taken in isolation, the cause of an increase in capacity utilisation could be ambiguous. It could either be as a result of less capacity being available and therefore growth in potential output has possibly declined, or it is indicative of an increase in actual demand (GDP). Furthermore, it is also possible that a combination of these two explanations are at play. However, when capacity utilisation data is assessed in conjunction with real GDP data (see Equation 5), these two effects can be disentangled and a more informed inference is made about the level of potential output and by natural extension, the output gap.

4.1.1 Data

Actual output – y_t in Equation (7) – is measured as the log of real GDP. Of the four explanatory variables in $\mathbf{X}_t$, three are observable. Growth in credit is measured as the quarterly log-difference of real private sector credit extension,[7] capacity utilisation is measured as the utilisation of production capacity in the manufacturing sector, as published by Statistics South Africa, while growth in house prices is measured as the log-difference in the real ABSA house price index.[8] Finally, since the output gap in Equation (7) averages zero in the long run, the explanatory variables in $\mathbf{X}_t$ are, where necessary, demeaned in order to average zero and remain stationary.

4.1.2 Results

The parameters for these four explanatory variables are estimated with Bayesian techniques using data from 1971Q1 to 2013Q4, and where applicable, the priors are guided by Borio et al. (2013). The parameter that measures the persistence of the output gap has a prior mean of 0.7 and is restricted to

[7] Both the series for nominal credit and nominal house prices are deflated by the seasonally adjusted Headline CPI.

[8] Available at http://www.absa.co.za/Absacoza/Individual/Borrowing/Home-loans/Property-Research

being positive, but less than 0.95. This upper bound is largely to avoid the parameter value approaching 1, which would lead to the output gap becoming a unit root process. The priors for both the financial variables – credit and house price growth – have a mean of 0.3, whilst the prior on capacity utilisation is set to a smaller value, as this variable often tends to dominate output gap estimation results given its strong correlation with excess demand in the economy.

Table 2: Estimation results

Dependant variable: $output\ gap_t$

	(1)	(2)	(3)	HP filter
$output\ gap_{t-1}$	0.93	0.844	0.867	-
	(20.58)	(21.31)	(24.89)	
$\Delta(credit_t)$	0.133	0.098	0.078	-
	(4.38)	(3.20)	(2.53)	
$capacity\ utilisation_t$	-	0.104	0.084	-
		(3.88)	(3.59)	
$\Delta(house\ prices_t)$	-	-	0.073	-
			(2.77)	
Mean absolute revision				
After 2 years	0.71	0.47	0.58	1.26
Relative to HP	0.56	0.37	0.46	1.00

* t-statistics in parentheses. 2-year mean absolute revisions calculated from 2000Q1 to 2013Q4.

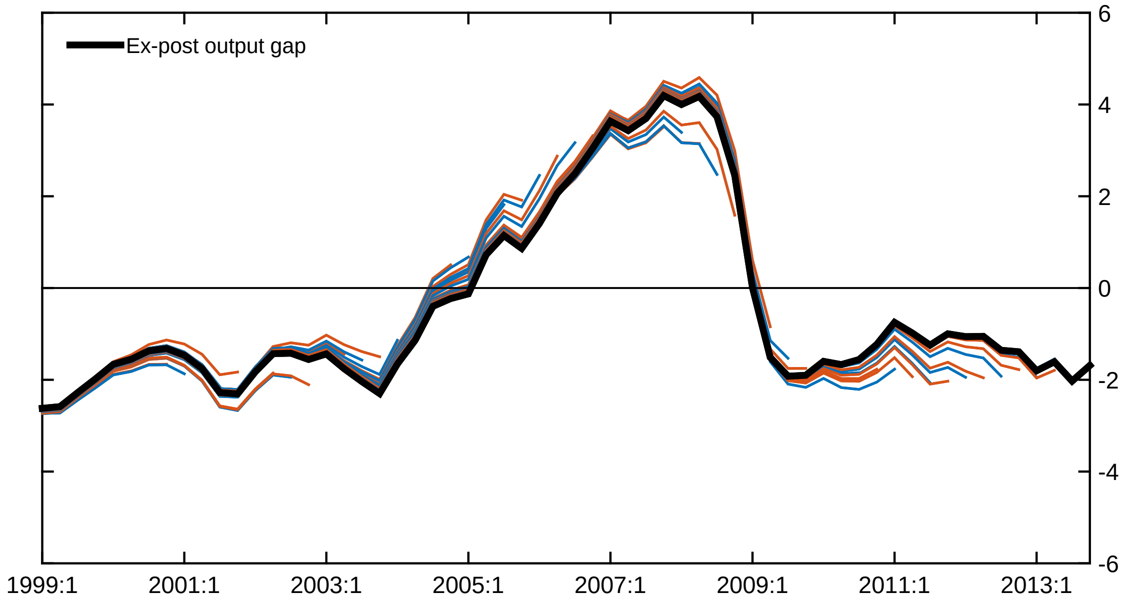
In Table 2, parameter estimates from three different specifications are shown.[9] The first specification only includes output gap persistence and credit growth as explanatory variables. Both variables are found to be significant explanators of the output gap. Considering the degree to which the real-time estimate of the output gap (*i.e.* the estimate in the current quarter) under this specification would be revised two years down the line, there is a remarkable improvement when compared to the magnitude of revisions to HP filter estimates. As such, the mean absolute revision statistics in Table 2 indicate that on average, real-time estimates from the first specification are revised by 0.71 percentage points, whilst the HP filter estimates are revised by 1.26 percentage points over the same horizon.

In the second specification, the level of capacity utilisation is included in the estimation. As before, all the variables are significant, but what needs to be highlighted here is the magnitude with which the mean absolute revision improves under this specification: compared to column (1), adding capacity utilisation improves the 2-year mean absolute revision from 0.71 to 0.47 percentage points. Moreover, this statistic is 63 per cent lower than the mean absolute revision under the HP filter.

In the third and final specification, growth in house prices is added to the existing set of explanatory variables. Although all variables are significant in this specification, the mean absolute revision deteriorates.

[9] The maximum of the posterior mode is reported.

Figure 4: The output gap according to the new measure of potential output



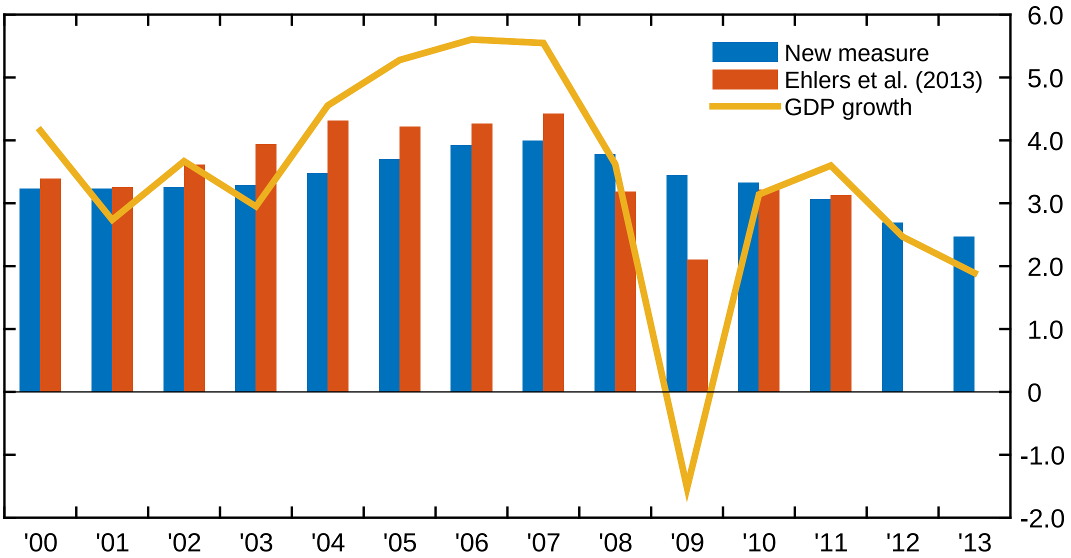
As a result of this deterioration in the reliability of the real-time estimate of the output gap when property prices are included, it becomes optimal to revert back to the second specification as the method of choice when estimating the output gap. Figure 4 shows the estimate of the output gap under the second specification, *i.e.* when only the lagged output gap, credit growth and capacity utilisation are included as explanatory variables. Figure 4 also highlights the improvement in the reliability of real-time estimates that is gained from using the new method, as opposed to other methods such as the HP filter in Figure 3.

4.1.3 Comparison against the SARB's current measure

Figure 5 compares the new measure of potential output to the existing measure of the SARB (as discussed by Ehlers et al., 2013). What becomes apparent from this comparison is the role of excessive credit extension during the build-up to the financial crisis – when accounting for pre-crisis credit growth, the potential growth rates are more subdued. Where the previous measure assigned the high GDP growth rates over this period to significant improvements in the productive capacity of the economy, the new approach recognises that growth over this period was partly fuelled by excessive credit extension, and did not necessarily translate into expanding productive capacity.[10] As a result, the economy would have been more overheated during the build-up to the crisis according to the new measure. Nevertheless, both measures indicate that the economy's medium-term potential growth rate averaged about 3.5 per cent over the comparable sample, and peaked during 2007, before declining thereafter.[11] This decline is in line with the international post-crisis experience. In fact, the new measure indicates that, over the medium term, South Africa's potential growth rate declined from 4.0 per cent in 2007 to 2.5 per cent in 2013.

[10]See Figure A.1 in Appendix A for the contribution of credit extension to the output gap.
[11]Table A.1 in Appendix A provides a detailed comparison of the potential growth estimates.

Figure 5: Comparison of the measures of potential output: annual growth rates



5 Conclusion

The financial crisis and the general moderation in global growth thereafter has reduced potential growth rates in many countries and adversely affected their levels of potential output. Some of the most notable sources of this reduction are the liquidity and credit availability constraints associated with this environment. Of importance, is whether these losses in potential output growth rates will be permanent or temporary.

A semi-structural approach is followed in this paper to estimate South Africa's potential output where financial effects are accounted for in the estimation process. It is shown that when financial factors are controlled for, the level of potential output is lower in the build-up to the financial crisis than what alternative methods suggest – implying that the positive output gap during the build-up was more pronounced. This is as a result of growth being fuelled by credit, that did not necessarily translate into additional productive capacity. Following the financial crisis, it is found that South Africa's potential growth has been slowing down. Finally, when compared to other frequently used methods for estimating potential output, this approach appears to deliver more reliable estimates of the output gap, especially in real-time.

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A Appendix

Figure A.1: Contribution of growth in credit extension to the output gap estimate

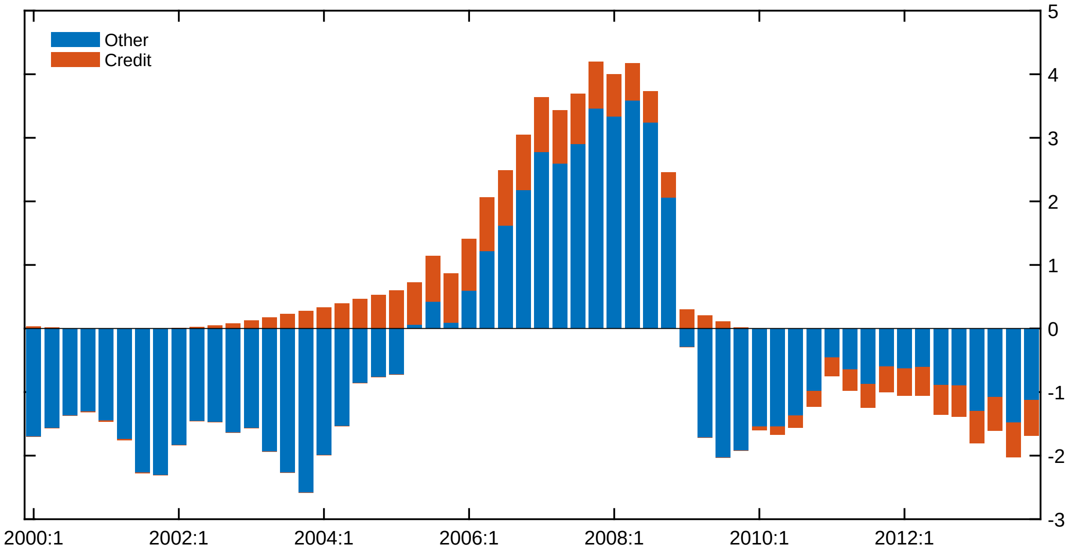

Table A.1: Comparison of the measures of potential output: growth rates

	New measure	Ehlers et al. (2013)	Actual GDP growth
2000	3.2	3.4	4.2
2001	3.2	3.3	2.7
2002	3.3	3.6	3.7
2003	3.3	3.9	2.9
2004	3.5	4.3	4.6
2005	3.7	4.2	5.3
2006	3.9	4.3	5.6
2007	4.0	4.4	5.5
2008	3.8	3.2	3.6
2009	3.4	2.1	-1.5
2010	3.3	3.2	3.1
2011	3.1	3.1	3.6
2012	2.7	-	2.5
2013	2.5	-	1.9
Average*	3.5	3.6	3.6

* Averages calculated over the comparable sample of Ehlers et al. (2013).