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Chris Loewald and Rashad Cassim

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Enquiries
Head: Research Department
South African Reserve Bank
P O Box 427
Pretoria 0001

Tel. no.: +27 12 313-3911
0861 12 SARB (0861 12 7272)

All about that base? Assessing the role of base effects in South African CPI inflation – November 2016[1]

Thulisile Radebe & David Fowkes

Abstract

The South African trade balance has improved significantly over the last three years from a 2.1 per cent of GDP deficit in 2013 to an estimated 0 per cent in 2016. According to the model developed in this note, roughly three-quarters of this improvement is cyclical and one quarter structural. If the export and import drivers were at their equilibrium (or structural) levels in 2016, the trade balance would have been -1,3 per cent of GDP – instead of the estimated 0 per cent. The trade balance could therefore deteriorate again should export and import values return to their trend values.

Introduction

2015 proved to be a good year for South African inflation. Headline CPI inflation reached a five-year low of 4.6%,[2] close to the mid-point of the target range, largely due to petrol price deflation.[3] In 2016, by contrast, inflation has breached the upper-end of the 3–6% target range, and is expected to average 6.4% for the year. The contrast between relatively low inflation in 2015 and relatively high inflation in 2016 suggests base effects are to blame. If so, the target breach may be a statistical mirage.[4] However, it is also possible higher inflation in 2016 reflects 'real' or contemporaneous inflation, from factors such as costlier food and lottery tickets.

To quantify these effects, we rely on a rolling sum approach based on monthly inflation rates, similar to that used by the European Central Bank.[5] Our results suggest base effects in 2016 were large enough to explain the target breach. However, base effects are in turn also responsible for inflation returning to target in 2017. The estimates are quite sensitive to specific choices around specifying whether a month's inflation rate is unusual or not, and as such these quantifications should be used with caution.

[1] Many thanks to Byron Botha, Franz Ruch, Rudi Steinbach, Siobhan Redford, Pamela Mjandana, Shaun DeJager, Shaista Amod, and Elmarie Nel for their valuable comments.

[2] Unless otherwise indicated, inflation numbers refer to year-on-year increases.

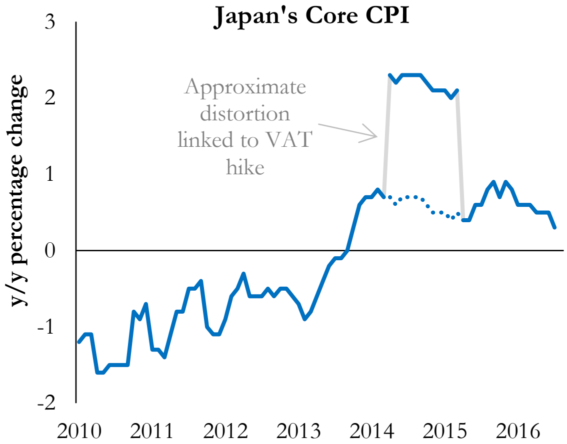
[3] Note that although food price increases were relatively supressed in 2015 due to the bumper crop in 2014 (of about 14.25 million tonnes), the largest contributor to the downward swing in headline CPI was from petrol prices.

[4] This possibility is raised in the research department's MPC post mortem for July 2016 "…the current outlook is strongly dominated by a *base effect* for the 2016 forecast due to inflation having been close to the mid-point in 2015, largely as a result of a decline in oil prices during that period. An important question is to establish how much of the increase in the inflation outlook is simply a *base effect* or mechanical, and how much of it has some measure of persistence embodied in it largely as a result of supply shocks that continue to persist for longer than expected…" (emphasis added).

[5] See European Central Bank (January 2005), "Base effects and their impact on HICP inflation in early 2005", Monthly Bulletin (Box 3: pg. 33 – 25). Available at: https://www.ecb.europa.eu/pub/pdf/other/mb200501_focus03.en.pdf

The base effect problem

A base effect occurs when a comparison between two data points creates the impression of a change in the more recent data point that is actually caused by a shift in the starting point. Base effects can cause dramatic moves in inflation rates, and may therefore be important for policymakers. For example, in April 2015 core inflation in Japan fell from 2.1% to 0.4%. This was not due to a disinflationary shock which struck the economy that month. Rather, the drop in inflation was entirely due to an increase in the VAT rate implemented in April 2014, a point of comparison that dropped out of the year-on-year inflation calculation in 2016.

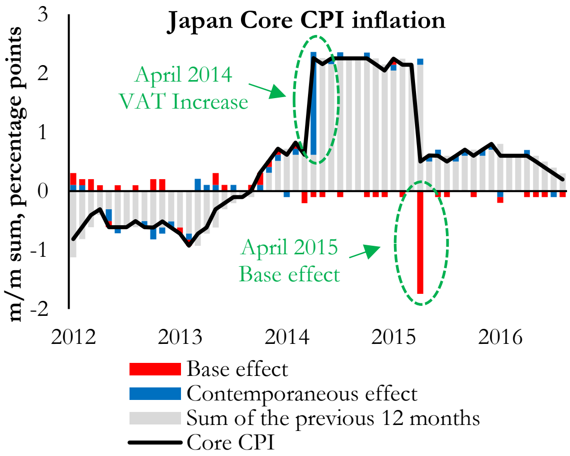


Method

To quantify base effects, we use a rolling sum approach. This relies on the fact that the sum of month-on-month changes in headline CPI during a particular year is approximately equal to the overall year-on-year percentage change in inflation. (For instance, a year-on-year rate of 6% inflation would follow from 12 months of 0.5% inflation.) As the rolling sum continues from time t to t+1, one month drops out of the sum and a new one is added. Any changes in CPI inflation from time t to t+1 can either be attributed to the first month falling away (the 'base effect') or the new month being added (a 'contemporaneous effect').

Of course, it would be unrealistic to treat the entirety of the departing month as a base effect, because then there would persistent base effects even in an economy with completely stable inflation. It would also be incorrect to subtract the incoming month from the outgoing month, as this would make it impossible to distinguish base effects from contemporaneous effects. Rather, this method requires some gauge of 'normal' inflation which can be subtracted from the new and old months to quantify the contemporaneous and base effects. The scale of the base effect is therefore measured as the difference between the average month-on-month rate and the departing number.[6] The base effect for the overall year is the cumulative sum of each base effect over the 12-month period.[7]

This approach works well for our Japan example. Using the 12-month rolling-sum, and an average over the period 2010-date, we find that the April 2014 VAT increase contributed approximately 1.7pp to a core CPI inflation rate of 2.2%. This increase then remained in the core CPI calculations for the next 11 months, before falling out in April 2015, when inflation slumped to 0.5%. In this case, the base effect is therefore 1.7%. This example also illustrates why it is necessary to use a cumulative sum, not just an average, when calculating the base effect. Note that the original April 2015 VAT increase features as a contemporaneous effect just once. Thereafter, contemporaneous effect are very small, reflecting new inflation shocks. However, to understand why inflation remained over 2% until April the next year, the legacy of the VAT increase is crucial. An average for the 12 month period would give a contemporaneous effect of just 0.1, leaving the year-long 'hump' in Japanese inflation a mystery.

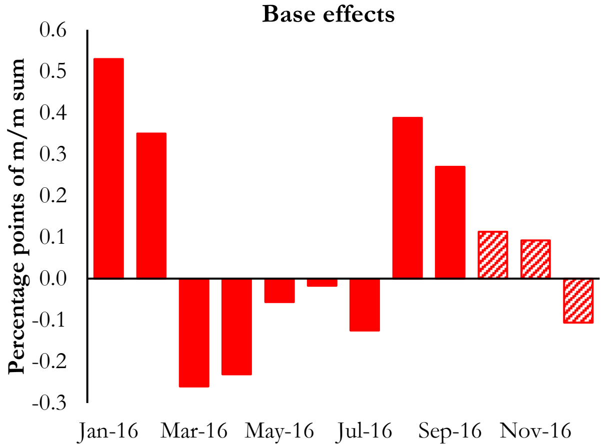


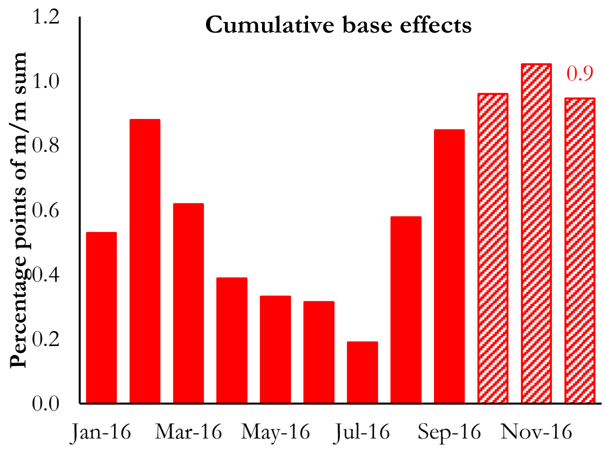
[6] See appendices.
[7] This follows an ECB methodology: see European Central Bank (February 2013), "Base effects and their impact on HICP inflation in 2013", Monthly Bulletin (Box 5: pg. 48 – 49). Available at: https://www.ecb.europa.eu/pub/pdf/other/mb201302_focus05.en.pdf

The same applies to the base effect over the following year.

Results

For South Africa, this methodology suggests the total base effect for 2016 was 0.9pp. Much of this comes from January and February 2016, with another large positive contribution in August and September. Both of these episodes reflect petrol price declines a year earlier. There are also some months with negative base effects, particularly during the second quarter. One explanation for these is changes in the petrol and RAF levies, with large increases in 2015 (80.5c) giving way to smaller increases in 2016 (30c).





It is worth noting that the 12 months comprising 2015 do not perfectly correspond with the oil shock. Rather, we see negative contemporaneous effects from September 2014, which then become positive base effects from late 2015. As a result, the twelve months from September 2015 to August 2016 have base effects of 1.6pp, substantially (0.7pp) more than for the calendar year 2016.

There are also positive contemporaneous effects for 2016, totalling 0.6pp. These reflect shocks such as higher food prices, vehicle prices and lottery tickets. As these contemporaneous effects are reversed in 2017, they become a base effect of -0.6pp. Without this base effect, headline inflation would not be subsiding below 6.0% in 2017.[8]

The most important objection to this technique is that the average used to quantify 'abnormality' is to some extent arbitrary. The results reported above rely on the average monthly rate of change for the seasonally adjusted targeted measure of inflation for the period 2000 to 2014 (that is, the inflation targeting period excluding the period under investigation). However, there are plausible alternative choices which would give quite different results.

Rationale	Period	m/m average	2016 base effect
Targeted inflation for entire inflation targeting period	Feb. 2000 - Sep. 2016	0.50	0.9
Since adoption of headline CPI as target inflation	Jan. 2009 - Sep. 2016	0.44	0.2
Post-crisis to date	Sep. 2009 - Sep. 2016	0.43	0.1
Post-crisis incl. forecasts	Sep. 2009 - Dec. 2018	0.45	0.3
IT period pre-2015	**Feb. 2000 - Dec. 2014**	**0.50**	**0.9**

One possible response to this problem is scepticism. Given answers ranging from minor (0.1pp in 2016) to substantial (0.9pp), it may be best to downplay the importance of base effects. Another response is to prefer one average to another, and trust those results. An advantage of the higher monthly average numbers is that they more closely approximate what seems to be the *de facto* inflation target.[9] The monthly averages

[8] All forecasts are based on the Disaggregated Inflation Model – August 2016 forecast.
[9] Nir Klein (2012) "Estimating the Implicit Inflation Target of the South African Reserve Bank" *IMF Working Paper 12/177*, available at: https://www.imf.org/external/pubs/ft/wp/2012/wp12177.pdf; Alain Kabundi, Eric Schaling

which give us higher base effect numbers entail annual inflation rates close to 6.0%.[10] The lower monthly averages, by contrast, imply annual inflation between 5.2% and 5.5%. Furthermore, the time periods which generate the lower numbers are shorter and include two significant disinflation shocks: the aftermath of the Great Recession and the oil price collapse, which biases them downwards. Our interpretation is that there are better reasons to use a monthly average around 0.5 than the other numbers considered above.

Conclusion

Base effects have led to higher measured inflation in 2016. Our methods indicate they added about 0.9pp to headline inflation, and this number would have been larger had the oil price collapse coincided more perfectly with the 2015 calendar year. However, 2016 outcomes also reflect contemporaneous movements in prices for food and core items, which contribute around 0.6pp to inflation. As these food and core shocks drop out of the base, they will flatter the 2017 inflation rate by the same magnitude. This figure is large enough to explain why inflation shifts back within the target range in 2017.

and Modeste Some (May 2016) *SARB Working Paper 16/05*, available at:
http://www.resbank.co.za/Lists/News%20and%20Publications/Attachments/7277/WP1605.pdf

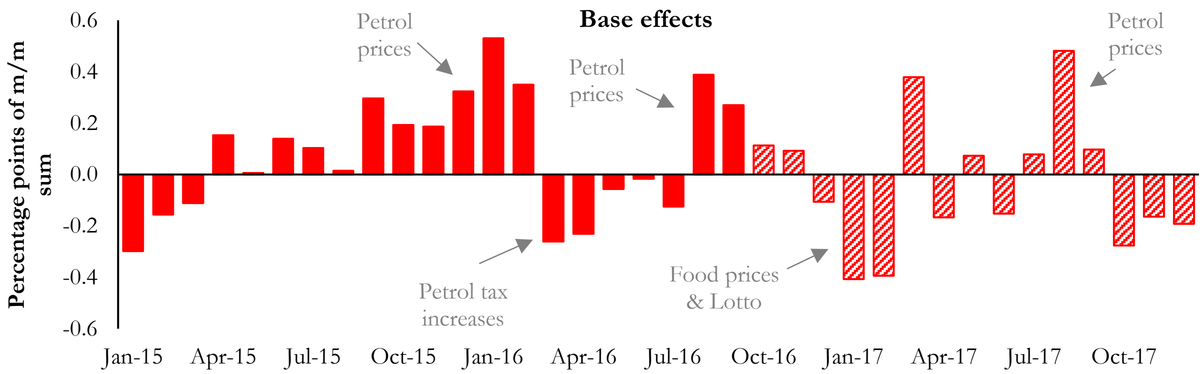
[10] Because the oil shock lowered inflation, a higher average number will create a bigger gap between actual and normal inflation, and therefore a larger base effect in 2016.

<u>Additional materials</u>

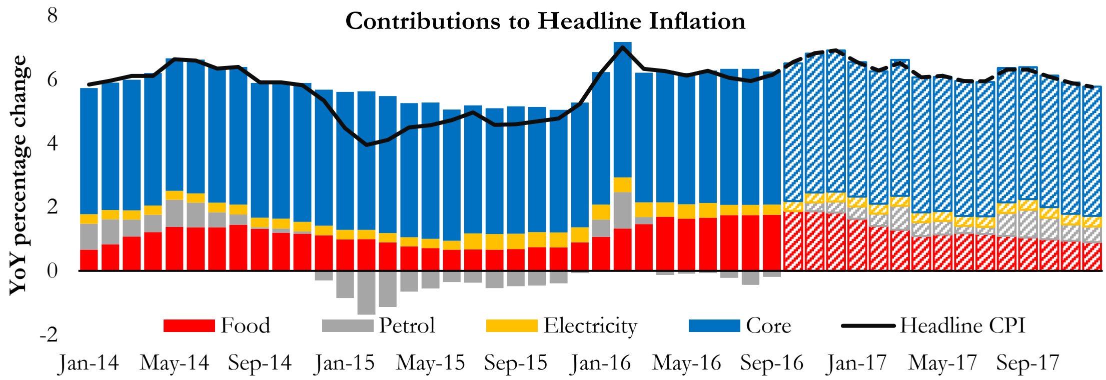
Base effects over time:

	Contemporaneous effect	Base effect
2007	2.2	1.1
2008	3.9	-2.2
2009	0.1	-3.9
2010	-2.6	-0.1
2011	-0.2	2.6
2012	-0.5	0.2
2013	-0.7	0.5
2014	-0.8	0.7
2015	-0.9	0.8
2016	0.6	0.9
2017	-0.4	-0.6

Base effects by month:



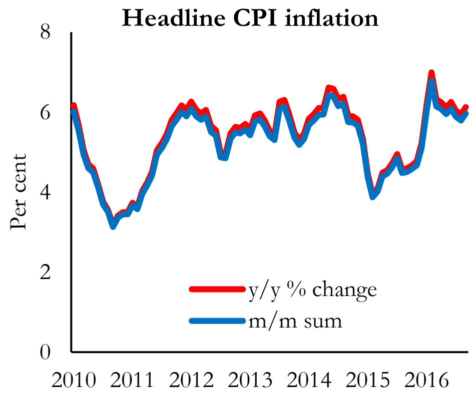
Headline CPI Contributions:



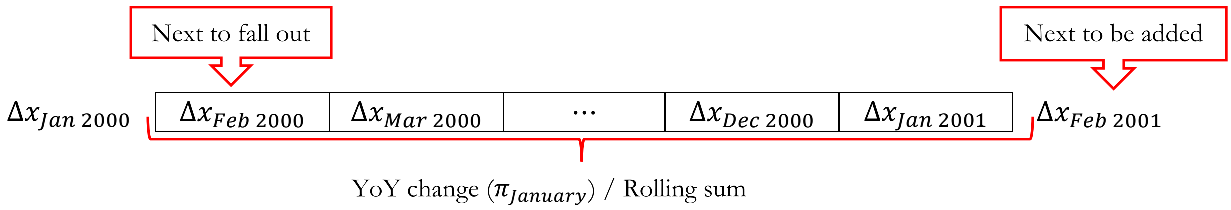
Appendix A: Base effects (12-month-rolling-sum perspective)

CPI inflation is measured on a year-on-year basis which loosely means that it contains the inflation pressures over the past 12 months. This is a good idea because it makes the definition of inflation conform to the intuitive notion that the inflation process is smooth (not volatile), however, it has the side effect that it can only contain 12 months' information[11], and so as you move forward some information must drop out. Mathematically it can be shown (see the technical appendix) that:

$$\pi_t \cong \sum_{i=1}^{12} \Delta x_{t-12+i}$$



The above simply says that the current inflation rate is equal to the sum of the past twelve months' month-on-month changes (in the level of the CPI price level). Here is a visualisation of the dropping out of the 12th month month-on-month change as you move from $\pi_{January}$ to $\pi_{February}$:



The distortion of the inflation rate due to the dropping out of this old information (which can be justified as no longer contributing to future inflation pressure) is called the base effect and it explains the pickups and falls mentioned earlier. This leads to the more accurate description of a change in the inflation rate:

$$\pi_{Feb\ 2001} - \pi_{Jan\ 2001} \cong \Delta x_{Feb\ 2001} - \Delta x_{Feb\ 2000}$$

And by taking the previous (January) inflation rate to the other side of the equals sign we now have a neat way of breaking up a given month's inflation rate:

$$\pi_{Feb\ 2001} \cong \pi_{Jan\ 2001} + \Delta x_{Feb\ 2001} - \Delta x_{Feb\ 2000}$$

That is, the inflation rate in February is equal to the inflation rate in January plus the growth added in February minus the growth last February which is no longer counted. We are not yet ready to give a formal definition of a base effect, because we want to separate what we intuitively think of as driving current inflation from the distortionary base effects. To do this we insert a wedge in between the two in the form of the average month-on-month change over a period to get:

[11] 12 months is not an arbitrary number of months since the seasons span 12 months, using 12-month inflation rates tends to average out seasonal patterns.

$$\pi_{Feb\ 2001} \cong \pi_{Jan\ 2001} + (\Delta x_{Feb\ 2001} - \overline{\Delta x}) - (\Delta x_{Feb\ 2000} - \overline{\Delta x})$$

So that we end up with the inflation rate in February being equal to the inflation rate in January plus the growth above the average growth added in February, minus the growth above the average growth last February which is no longer counted. In this way only above average growth and distortionary effects are taken into account and we end up with an intuitive definition of a base effect. A base effect is thus the contribution to the change in the rate in inflation that comes from month-on-month growth rates that deviate from an amount in excess of the average dropping out of the base.

Appendix B: Technical appendix

The approximate equivalence of the product and sum of small changes

For small changes in x and y:

$$\Delta xy = \frac{x_1 y_1 - x_0 y_0}{x_0 y_0}$$

$$\Delta xy = \frac{x_1 y_1}{x_0 y_0} - 1$$

$$\Delta xy = \left(\frac{x_1}{x_0}\right)\left(\frac{y_1}{y_0}\right) - 1$$

$$\Delta xy = (1 + \Delta x)(1 + \Delta y) - 1$$

$$\Delta xy = 1 + \Delta y + \Delta x + \Delta x \Delta y - 1$$

$$\Delta xy = \Delta y + \Delta x + \Delta x \Delta y$$

$$\Delta xy \cong \Delta y + \Delta x$$

Since

$$\Delta x \Delta y \cong 0$$

The approximate equivalence of small year-on-year changes with the sum of the past 12 month-on-month changes

Thus for $\Delta_{12} x_t$ (year-on-year change):

$$\Delta_{12} x_t = \frac{x_t - x_{t-12}}{x_{t-12}}$$

$$\Delta_{12} x_t = \frac{x_t}{x_{t-12}} - 1$$

$$\Delta_{12} x_t = \frac{x_{t-11}}{x_{t-12}} \cdot \frac{x_{t-10}}{x_{t-11}} \cdots \frac{x_{t-1}}{x_{t-2}} \frac{x_t}{x_{t-1}} - 1$$

$$\Delta_{12} x_t = \Delta x_{t-11} x_{t-10} \cdots x_t$$

$$\Delta_{12} x_t \cong \sum_{i=1}^{12} \Delta x_{t-12+i}$$

Decomposing changes in year-on-year inflation into growth and base effects

It follows directly from the second result that

$$\Delta_{12} x_t \cong \Delta_{12} x_{t-1} + (\Delta x_t - \Delta x_{t-12})$$

Rearranging gives

$$\Delta_{12} x_t - \Delta_{12} x_{t-1} \cong \Delta x_t - \Delta x_{t-12}$$

If the average month-on-month growth rate is $\bar{x}_t$,

Then we can rewrite the previous equation as

$$\Delta_{12}x_t - \Delta_{12}x_{t-1} \cong +(\Delta x_t - \Delta x_{t-12}) + \bar{x}_t - \bar{x}_t$$

Rearranging gives

$$\Delta_{12}x_t - \Delta_{12}x_{t-1} \cong (\Delta x_t - \bar{x}_t) - (\Delta x_{t-12} - \bar{x}_t)$$

Which gives us the following two definitions

$$growth\ effect \cong (\Delta x_t - \bar{x}_t)$$

$$base\ effect \cong -(\Delta x_{t-12} - \bar{x}_t)$$