South African Reserve Bank
Occasional Bulletin of Economic Notes
OBEN/19/02

South African Reserve Bank Economic Notes are typically short economic analyses initially written for internal discussion and to stimulate debate. They are written by staff members of the South African Reserve Bank or visiting fellows and are released publicly on an occasional basis.

Authorised for publication by:

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August 2019

South African Reserve Bank

SARB Occasional Bulletin of Economic Notes
August 2019

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OBEN 1902* – May 2019

A novel supply-side approach to estimating the impact of load shedding on GDP growth in South Africa

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Abstract

This note aims to quantify the impact of electricity shortages on 2019 GDP growth using a disaggregated supply side approach. We find that load shedding will have the largest negative impact on energy intensive sectors such as mining, manufacturing and electricity. We estimate the impact to be around 0.5 percentage points on the quarter on quarter annualised GDP growth rate in 2019Q1 (0.1 pp on 2019 annual GDP growth if load shedding does not persist over the next 3 quarters and there is no rebound in the subsequent quarters). If load shedding persists throughout the year, to a similar extent experienced in 2019Q1, then it could shave-off about 0.3 pp from the annual growth rate. To generalise our results, our analysis suggests that the economy will lose approximately R348 million per day on stage 1 load shedding and R753 million on stage 4 (in nominal terms).

1. Introduction[1]

Recently, there has been market concerns regarding the impact of load shedding on GDP growth in South Africa. An internal note by Mpini, Walter & Makrelov (2019)[2] uses a computational general equilibrium (CGE) model to analyse this impact. While they estimate that annual growth will be reduced by 1.1 percentage points (pp) in 2019, they don't quantify the impact of load shedding on first quarter growth. We now know the full extent of load shedding in the first quarter. By employing a different methodology to estimate the first quarter growth impacts, we assess the direct impact of shortages on each sector's output (from the production side). This allows us to account for sector-specific characteristics. The estimates from this method are then used to guide the QPM's forecast (particularly the starting point- 2019Q1), as such a scenario cannot be directly done in the QPM.

2. Method used to estimate the effect of load-shedding

To estimate the impact of load shedding on GDP, we use production hours (calculating the gross value added (GVA) per hour - see Equation 1). Given the number of days in which there was load shedding and the corresponding stages, we determine the total number of production hours lost due to load shedding. With this information, we can now estimate the total GVA lost by each sector (Equation 2).

$$GVA\ per\ hour\ =\ Total\ GVA\ /\ (Working\ days\ *\ production\ hours\ per\ day) \quad (1)$$

[1] Many thanks to the management team of Policy Development and Research division for their valuable comments and suggestions.

[2] For more details on the background of load shedding in South Africa see Mpini, Walter & Makrelov, 'Estimating the economic impact of electricity shortages', *South African Reserve Bank Economic Note No. 2019/08*, April 2019.

$$Total\ GVA\ lost\ =\ GVA\ per\ hour\ *\ Total\ load\ shed\ hours \quad (2)$$

As known, production does not entirely depend on electricity. While electricity is one of the key inputs in the production process, it is not the sole input. Some operations can still continue in the absence of electricity. Therefore, to get the GVA lost per sector purely due to load shedding, we adjust the total production lost with a measure of electricity intensity of GVA for each sector (Equation 3)[3]. Aggregating the GVA lost per sector gives the overall impact on GDP.

$$GVA\ lost\ to\ load-shedding\ =\ Total\ GVA\ lost\ *\ Energy\ intensity\ of\ GVA \quad (3)$$

3. Results

We first estimate the impact of load shedding experienced in 2019Q1 using the January 2019 MPC forecast for the first quarter as a baseline scenario that fully excludes any impact of electricity shortages[4]. In this first scenario, we assume no further load shedding for the remainder of the year. We then extend the analysis by estimating the impact assuming load shedding persists for the rest of the year with each quarter experiencing load shedding to the same extent as seen in 2019Q1.

3.1 Load shedding for a single quarter (2019Q1)

The 2019Q1 electricity outages resulted in a total of approximately 65 hours of load shedding over a 15 day period (Table 1). Depending on the stage of load shedding, the number of hours per day varied with some being in the evening after official business hours[5]. Importantly, 5 out of the 15 days fell on a weekend (including a public holiday), with 3 out of the 5 days being stage 4 load shedding.

Given information on how load shedding is implemented by Eskom[6], we calculated the average load shedding hours per stage rounded-off to the nearest hour (for example, with stage 1 we have load shedding 3 times over a four day period for two hours at a time. To calculate the hours load shed in stage 1 we get 3*2/4=1.5, which will then be rounded off to 2). It is worth noting that Eskom implements load shedding in 2 hour blocks at a time[7]. It is also applied in such a way that all customers are treated as fairly as possible. Therefore, under normal circumstances, each customer will experience load shedding for only the prescribed hours per applicable load shedding stage and not for the whole day[8]. Electricity outages lasting for longer than the prescribed hours per stage would normally be due to other reasons (such as cable theft).

[3] To estimate the electricity intensity of GVA for each sector we use the 2017 supply-use tables.
[4] The March 2019 MPC forecast had indirectly factored in the load shedding impact in as far as it was captured through sentiment indicators, as such it cannot be used as a baseline scenario.
[5] Note, we do not take into account the effect of load shedding on households as we are working from the production side and not the expenditure side.
[6] According to ESKOM, the frequency of load shedding increases as higher Stages are used;

- Stage 1 is load shedding for 3 times over a four day period for two hours at a time.
- Stage 2 will be scheduled for load shedding 6 times over a four day period for two hours at a time.
- Stage 3 means you will be scheduled for load shedding 9 times over a four day period for two hours at a time.
- Stage 4 requires load shedding for 12 times over a four day period for two hours at a time. (http://loadshedding.eskom.co.za)

[6] Eskom supplied Johannesburg areas are an exception to this, with 4 hour blocks at a time.
[7] Eskom supplied Johannesburg areas are an exception to this, with 4 hour blocks at a time.
[8] While load shedding itself happens throughout the day, different customers are affected at different times.

Table 1[9]: Number of days load shed and average hours per stage in 2019Q1

Stages	Hours	Days	Total hours per stage
Stage 1	2	1	2
Stage 2	3	5	15
Stage 3	4	3	12
Stage 4	6	6	36
Total		15	65

In this analysis, we assume that evening load shedding hours and those that fall on a weekend affect households more than some industries. As such, the assumption of total load shedding hours per industry varies depending on whether production in that particular industry is during normal business hours or over a 24 hour period (for example, the finance sector is assumed to work for only 9 hours a day, the manufacturing sector works a little longer - 12 hours a day, while production in the mining sector is non-stop). It is for this reason that some industries would only be affected for 26 of the total 65 load shed hours. On average we assumed that there were 70 working days in the quarter reflecting a regular Monday-Friday work week. For the mining, electricity and transport sectors, however, we assumed that production does not stop over weekends and therefore 90 working days were factored into the calculation for these sectors (Table 2).

Table 2: Assumptions made for each sector

	Agriculture	Mining	Manufacturing	ElectricityGasWater	Construction	Trade	Transport	Finance	Community
Working days per quarter	70	90	70	90	70	70	90	70	70
Production hours per day	9	24	12	24	9	9	12	9	9
Total load shed hours for the quarter	26	65	26	65	26	26	26	26	26
Electricity intensity of GVA	0.06	0.11	0.09	0.25	0.01	0.02	0.01	0.03	0.01

Given the assumptions made on the various industries, the GVA per hour approach suggests a total of R3.8 billion (approximately R5.8 billion in nominal terms) was lost in real GVA in 2019Q1 (Table 3)[10]. This would shave-off 0.5 pp from the 2019Q1 quarter on quarter (q-on-q) annualised GDP growth number. Thus, given the January 2019 MPC baseline forecast for 2019Q1 of 1.2% q-on-q annualised, the load-shedding-adjusted GDP outcome will instead be 0.7% q-on-q annualised. The largest contributors to the decrease are the energy intensive sectors (mining and manufacturing). The impact on the electricity, gas and water industry is largely due to actual lower production of electricity. For the year, GDP growth is 0.1 pp lower than in the baseline (assuming that there are no changes on the other quarters relative to the baseline).

This analysis does not take into account Eskom's load curtailment agreements with some of the large industries[11]. Under this agreement, industries reduce their consumption of electricity instead of being load shed by Eskom. This means that they are able to decide on which non-essential production processes to switch-off temporarily to make up for the load required by Eskom, while core production can, to some

[9] Information on the actual days of load shedding and the applicable stage on the day was obtained from the Eskom twitter account.

[10] To get an estimate of GDP at market prices lost we have to add taxes and subtract subsidies for which we do not have an estimate.

[11] Under the load curtailment agreement, Eskom can instruct some of the large industries to reduce electricity consumption when it is urgent to balance the system. They are able to reduce their load by up to 20%, significantly easing capacity on the grid; but it takes a minimum of 2 hours to implement.

extent, still continue. This might minimise the impact of load shedding on production. Therefore, as this is not accounted for in our analysis, the impact may be overestimated.

Table 3: Impact on each sector

Industry	Nominal GVA lost (R Million)	Contribution to growth (Baseline)	Contribution to growth (with load shedding)	Contribution to decline in growth
Primary sector:	**1356**	**0.23**	**0.11**	**-0.12**
Agriculture	259	0.14	0.12	-0.02
Mining and quarrying	1098	0.09	0.00	-0.09
Secondary sector:	**2375**	**-0.17**	**-0.37**	**-0.20**
Manufacturing	1582	-0.12	-0.25	-0.13
Electricity, gas and water	745	-0.03	-0.09	-0.06
Construction	48	-0.03	-0.04	0.00
Tertiary sector:	**2030**	**1.03**	**0.86**	**-0.17**
Trade sector	584	0.12	0.07	-0.05
Transport and storage	141	0.17	0.16	-0.01
Financial sector	979	0.42	0.34	-0.08
Community sector	326	0.32	0.29	-0.03
Gross value added (basic prices)	**5762**	**1.08**	**0.59**	**-0.49**
Taxes on products	0	0.08	0.08	0.00
Subsidies on products	0	0.01	0.01	0.00
GDP at market prices	**5762**	**1.16**	**0.67**	**-0.49**

The results in this analysis can be generalised to get an estimated impact on growth per stage of load shedding. Table 4 summarises the results. The estimates are consistent with the assumed average load shedding hours per stage and the sector specific production hours per day (consistently, load shedding hours outside an industry's production hours have no impact). The results suggest the economy will lose approximately R773 million per day on stage 4 load shedding. Again, these estimates do not take into account Eskom's load curtailment agreements which might lessen the impact.

Table 4: Impact per load shedding stage

Stages	Hours	Real GVA lost (Millions)	Nominal GVA lost (Millions)
Stage 1	2	239	358
Stage 2	3	258	386
Stage 3	4	277	415
Stage 4	6	515	773

3.2 Load shedding for the whole year

In estimating the impact of load-shedding that persist the whole year, we make an assumption that load shedding in subsequent quarters of the year will be similar to that of the first quarter. The stages and the number of load shedding days were assumed to be the same as what was experienced in the first quarter. Given the linear nature of the methodology we use, the impact in a given quarter or year is independent of the quarter or year in question. Therefore, with identical assumptions, q-on-q annualised GDP growth will be 0.5 pp lower in each quarter relative to baseline. On an annual basis, this scenario will result in growth

being 0.3 pp lower than baseline in 2019. The impact could potentially be higher if load shedding persists at a more intensified level than in 2019Q1.

Compared to other[12] estimates that are ranging between 0.4 and 1.3 pp (see Mpini, Walter & Makrelov (2019)), our estimate seems to be very low. However, this is because the studies assume load shedding will persist at higher levels for the whole year, while our estimate only shows if load shedding persists to a similar extent as experienced in 2019Q1 (which was not as intensive - see Table 1). In addition, our estimate is based on a mix of load shedding stages (which is exactly what was realised in 2019Q1 and what is more likely to happen going forward) rather than assuming a stage 4 throughout the load shedding period. If we were to make a very strong assumption like in those studies, our estimate would also be as high.

We tested the sensitivity of the results obtained in this analysis to different ways of measuring GVA per hour per sector. In particular, we assessed how sensitive our results are to various past measures of GVA per sector used to calculate GVA per hour. This is important as events such as the drought could reduce GVA per hour to an extent that production lost to electricity outages is understated. We used the average of the past five years' 1st quarter GVA compared with an annual average of 2018[13]. The results were not meaningfully different.

4 Conclusion

In this note, we estimate the impact of electricity shortage on the first quarter of 2019 GDP growth from the supply side. Unsurprisingly, we find that electricity shortages will have a negative impact on GDP, with mining, manufacturing and electricity production being affected the most. We estimate about a 0.5 pp drag on the q-on-q annualised GDP growth rate in 2019Q1 (0.1 pp drag on 2019 annual GDP growth if load shedding does not persist over the next 3 quarters). However, if load shedding persists throughout the year, to the same extent seen in 2019Q1, then it could subtract about 0.3 pp from the annual growth rate. This analysis is sensitive to the assumptions made and the impact could be larger if load shedding becomes more severe over the next three quarters.

Our estimates are subjected to several limitations. Firstly, it doesn't take into account the indirect effects of load-shedding on sentiments and hence GDP. This is especially true should load shedding persist for the whole year. Secondly, we also do not take into account longer term costs due to lost investment or additional damages to government finances. Lastly, this analysis does not capture Eskom's load curtailment agreements with some of the large industries, which could imply the impact could be lower.

[12] Estimates by National treasury, Goldman Sachs, RMB Morgan Stanley, Free market foundation and Old Mutual.
[13] We also did this for the 2nd, 3rd and 4th quarter GVA, to test whether the results might be different for each quarter and the results were unchanged.