The Possible Effects of the Extended Lockdown Period on the South African Economy: A CGE Analysis

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Abstract

The economic effects of the lockdown period in South Africa will be devastating. We simulated the industry level capacity constraints imposed by the lockdown regulations since 27 March 2020 on all industries in South Africa by reducing the amount of capital and labour available for production. We found a decrease in real GDP to 10% below the baseline level in 2020, and recovery of all industries and macroeconomic variables towards the baseline by 2027. Industries that are suffering and would continue to suffer are the hospitality and tourism industry and all industries related to it, such as transport services, as well as beverages and tobacco. Manufacturing in general is also hard hit because they were prohibited to let large groups of labourers enter their premises. The model shows that most manufacturing will suffer throughout the forecast period, which was modelled up to 2027.

Keywords: Lockdown, COVID-19, South African economy

1 INTRODUCTION

On Thursday, 5 March 2020, the National Institute for Communicable Diseases in South Africa confirmed that a suspected case of COVID-19 had tested positive. The patient was a 38-year-old male who had travelled to Italy with his wife as part of a group of ten people. They arrived back in South Africa on 1 March, 2020.

What followed after 5 March is history fresh in our minds. Under Section 3 of the Disaster Management Act, (Act No. 57 of 2002) the government of South Africa implemented lockdown regulations and put the country in Level 5 from 27 March to 30 April. The level 5 lockdown regulations were gradually eased to lockdown levels 4, 3, 2 and into level 11 at the time of writing this article. Specific work and operational regulations applied to different industries under each level. These regulations specified the capacity at which industries were allowed to operate, how many workers they could allow onto their premises and what types of commodities they were allowed to produce. Each Level had specific restrictions on the movement of households and labourers. These regulations severely impacted the economy, level of employment and people's ability to earn income. The International Monetary Fund (IMF) estimated that the Gross Domestic Product (GDP) would fall by 8% (IMF, 2020a). The Labour Force Survey for quarter 2 of 2020, indicated that the number of employed persons decreased by 2.2 million to 14.1 million compared to the first quarter of 2020. The unemployment rate according to the expanded definition of unemployment increased to 42% in quarter 2 of 2020 (StatsSA, 2020e). In this paper, we use the computable general equilibrium (CGE) model of the University of Pretoria, called "UPGEM," to estimate the direct and indirect effects of the lockdown regulations on the economy of South Africa and

forecast these effects for the next 7 years for the macro economy as well as the various industry groups.

The structure of the paper is as follows: Section 2 describes our methodology, including a description of the model and its database. Section 3 describes the modelling simulations that we run. Section 4 presents and interprets the modelling results and Section 5 concludes the paper with an overview of the findings.

2 THE MODEL

A CGE model provides an ideal framework to evaluate the impact of the lockdown period on the SA economy, because it captures the production structure of each industry in the economy in terms of employing capital and labour, as well as using intermediate goods in the production of one or more commodities. The model shows detailed linkages between all the industries in the economy, as well as the final demand for each industry's output by households, the government, investors and foreigners.

However, how does one use a CGE model to measure the impact of lockdown regulations on the economy? Do you shock the supply side and let the model determine the effects on demand or do you estimate how demand would decrease for different commodities and allow the model to determine the effects on employment and capital?

The government implemented regulations that directly constrained production capacity of most industries in the economy. Their doors were closed and workers could not go to work. In our view THAT is what to shock the model with. Intermediate and final demand changed as a secondary effect to the primary shock of not being able to produce. In the baseline there was no pandemic and industries produced at full capacity. After the declaration of a state of disaster, capacity was constrained. We had good information on which industry was allowed to do how much and could model that directly. We did not have information about changes in demand. In general, we believe one should model the direct impacts and let the model determine the results and not the other way around.

In 2014 the platinum mining industry in South Africa came to a standstill for 5 months during a strike for higher wages in the first half of the year. Bohlmann *et al*. (2015) estimated the immediate and longer term impacts of the strike, using UPGEM in an ingenious way. They kept the capital stock of the platinum mining sector in the model inactive for 6 months of the year, together with the proportion of the national labour force equal to the size of the labour force in the platinum industry and measured the impacts of this inactive period.

Putting the country into lockdown is similar to a general strike: labour is forced by law to lay down tools and capital, therefore, also lies dormant during this time. The platinum mines came to a complete standstill for 5 months, while under lockdown industries could operate at various levels. We use the same techniques as Bohlmann *et al*. (2015), namely to (i) make the capital stocks of all affected industries inactive or partly inactive for specific periods of time and (ii) reduce equivalent proportions of the labour force that are employed in each industry.

2.1 The UPGEM Model

UPGEM is a Monash style model,2 which is a linearised system of equations describing the theory underlying the behaviour of producers and consumers in the economy. Industries in

UPGEM produce output by combining commodities sourced from the domestic and foreign market, land, capital and labour. The demand equations for these inputs are derived from solving optimisation problems. For example, in determining the demand for occupation-specific labour, an industry chooses a combination of occupations to minimise labour cost subject to a constant elasticity of substitution (CES) production function. The demand equations for the primary factors and intermediate commodities are determined by solving similar optimisation problems. In creating capital, local investors choose inputs from domestic and imported sources to minimise costs subject to a CES production function. We assume that imports are imperfect substitutes to the local equivalent. These source-specific demand equations are also derived from solving optimisation problems subject to a constant elasticity of substitution (CES) production function.

UPGEM has one representative household. The household's optimisation problem is solved in two stages. In the first stage the household chooses a combination of composite commodities to maximise utility subject to a budget constraint. In the second stage, the household chooses where to source these commodities from – either from the domestic or foreign markets. The export demand equations for South African commodities are negatively sloped and relates export volume inversely to the foreign currency price. UPGEM has one central government that consumes commodities sourced from both the domestic and foreign market. Government demand is often determined exogenously, but in our simulations it is linked to aggregate household consumption. Markets clear and all sectors are assumed to be competitive.

UPGEM recognises two dynamic adjustments: the lagged labour market adjustment and capital accumulation mechanisms (Dixon *et al*., 2013:4-10). These dynamic relationships allow UPGEM to explicitly track each variable through time at annual intervals. For example, the capital accumulation mechanism guides the capital market from a short-run environment (where capital is fixed and rates of return flexible) to a long-run environment (where capital adjusts and the rates of return are fixed). While we do not explicitly define short-run and long-run closures in year-on-year simulations, the capital accumulation mechanism leads the economy to a long run state that can be described by the exogenous status of rates of return.

The capital accumulation mechanism in UPGEM allows each industry to accumulate capital. Industry-specific capital at the end of year t is calculated as capital at the start of year t plus net investment undertaken during year t. Changes in industry-specific investment are linked to changes in industry-specific rates of return. UPGEM also includes a mechanism that moves the labour market from a typical short-run scenario (employment adjusts while the real wage remains sticky) to a long-run scenario (real wage adjusts while employment remains unchanged from the baseline). Typically, a positive (negative) labour market outcome manifests in the short-run as an increase (decrease) in employment away from the baseline, while real wages remain sticky. In the long run, a positive (negative) outcome manifests as an increase (decrease) in the real wage away from the baseline while employment moves towards the baseline.

2.2 The UPGEM Database

The current database captures the structure of the South African economy and is calibrated to the 2017 Supply-Use Table (SUT) (StatsSA, 2020a). The database captures production and sales of 40 commodities and industries. UPGEM requires matrices for basic, tax and margin flows of commodities sourced and sold on domestic and foreign markets. Local industries

produce commodities that can be used as intermediate input by local industries, by investors, the representative household, the government or sold on the foreign market. For each commodity valued at basic price, we have a margin matrix showing the cost of margin services (trade and transport) used to facilitate the flow of commodities from all sources to the users of these commodities. Users of commodities also pay indirect taxes such as VAT and excise tax. The value of commodities by users valued at the purchaser's price is determined as the sum of the flows of source-specific commodities valued at basic price, margin costs and indirect commodity taxes.

The model also requires matrices for the factors of production, namely labour, capital and land. In UPGEM, the use of the factors of production is limited to industries in current production. We further restrict the use of land and natural resources to the agricultural and mining industries. Only industries pay production taxes. Industry-specific production cost is calculated as the sum of inputs, namely sources-specific commodities used as intermediate inputs, factors of production and production tax.

The database includes a multi-product matrix showing the basic value of commodities produced by local industries. In UPGEM, the multi-product matrix is strongly diagonal with some off-diagonal values. This means that some industries produce more than one commodity, but mostly one specific commodity. For example, the industry called Metal Ores produces mostly metal ores (97%) and a small amount of other mining (3%). The database is balanced in that industry costs are equal to domestic commodity sales valued at basic price.

3 SIMULATION DESIGN

We run two simulations with UPGEM. The first simulation is the business-as-usual (BAU) scenario which models the growth of the SA economy in the absence of COVID-19 and the subsequent lockdown measures. The second simulation is the "policy" simulation which generates a second forecast that includes all the exogenous features of the BAU simulation, plus the policy-related shocks reflecting the impact of the lockdown period during 2020. Since all the lockdown regulations that we attempt to model in this paper are government policies, we will continue to use the familiar modelling expression "policy simulation."

3.1 Baseline Simulation

The baseline simulation represents the growth in the South African economy before the arrival of COVID-19 and the subsequent policy measures. In developing this simulation, we introduce forecast data from the International Monetary Fund's (IMF) World Economic Outlook database (IMF, 2020b).3 Specifically, we adopt the forecasts for real GDP, population growth and inflation.

We use employment data from Statistics South Africa to determine the annual percentage change in employment (StatsSA, 2020d). Real wages have been positive for decades due to the existence of strong labour unions in South Africa and in the baseline, we assume that this practice would remain and that real wages would increase by 0.5% per annum. The result is that the capital/labour ratio changes over time, in favour of capital.

As the South African economy grows, so does the rest of the world. In UPGEM, changes in world trading conditions occur via changes in the position of the downwards sloping export demand curves and changes in the foreign currency price of imports. In our BAU simulation,

we assume that the foreign demand for South African expands at a rate that keeps the average price of exports unchanged. We also assume that the foreign-currency import prices remain unchanged. This, and our assumption about export prices, means that the terms of trade remains unchanged over the simulation period.

Normally, forecast data are available for naturally endogenous variables.4 By changing the endogenous/exogenous status of variables, we change the closure and allow exogenous variables to be shocked. For example, GDP is a naturally endogenous variable and economy-wide productivity change is naturally exogenous. By swapping the GDP with the economy-wide productivity variable, we render GDP exogenous and productivity endogenous. We can now directly introduce shocks, such as the IMF forecast, to GDP. The model will then determine the change in productivity.

Our starting point is the database year, which is 2017. In developing the baseline simulation, we incorporate the year-on-year percentage change in observed data (for 2018 and 2019). From 2020 to 2024, we incorporate the year-on-year percentage change in the data adopted from the IMF (2020b). From 2024 to 2027, we assume constant growth rates for these variables. Table 1 summarises the baseline shocks for selected macroeconomic variables.

Table 1. Variables shocked in the BAU simulation (year-on-year percentage change)

No	Year	Real GDP[a]	Employment[b]	Population[a]	CPI[b]
1	2018	0.787	2.571	1.473	4.620
2	2019	0.655	1.120	1.526	2.383
3	2020	1.079	1.100	1.525	5.169
4	2021	1.439	1.080	1.524	5.300
5	2022	1.763	1.060	1.526	5.300
6	2023	1.783	1.040	1.525	5.300
7	2024-2027	1.775	1.020	1.525	5.300

[a] IMF (2020).

[b] Statistics South Africa (2020d).

The results of the policy simulation are typically reported as percentage deviations away from the BAU simulation. UPGEM is solved using GEMPACK (Harrison and Pearson, 1996; Horridge *et al*., 2018).

3.2 Policy Simulation

The second simulation is the policy simulation. This simulation incorporates all the features of the BAU simulation, plus shocks capturing the impact of the lockdown period. We impose negative shocks in 2020 and thereafter, we assume a return to full capacity of all industries within 2 years.

3.2.1 Closure and Macroeconomic Assumptions

The labour market mechanism in UPGEM allows the labour market to transition from a short-run environment (sticky real wages and employment adjusting) to a long-run environment where the real wages adjust and employment moves to its long run base level. Thus, in the short run, employment can deviate from the baseline level while real wages remain sticky. As real wages adjust, the deviation in employment is eliminated so that in the

long-run, policy outcomes are reflected as changes in real wages rate rather than national employment.

Capital and investment are specific to each industry. UPGEM allows for short-run deviations in expected rates of return from their baseline levels. These cause deviations in investment and hence, capital stocks, which gradually erode the initial deviations in rates of return. Provided there are no further shocks, rates of return revert to their baseline levels in the long run.

In the policy simulation for the current experiment, we keep a proportion of capital dormant in each industry, according to our estimation of the period of time in 2020 that the relevant industry was unable to operate, due to the lockdown regulations. We also keep the weighted amount of overall labour in the economy dormant, which matches the total amount of capital in the economy, but rely on the model to reduce labour at an industry level by an appropriate amount. In 2021 and 2022, we return capital and labour to their baseline path, taking into consideration depreciation of capital.

The external shocks that we apply to the capital stocks in industries cause the rental rates of capital in these relevant industries to increase, much higher than the cost of buying another unit of capital – the cost of investment in each industry. Under normal circumstances investors would, therefore, be keen to invest in these industries with high expected rates of return. In reality, however, there are no shortages of capital in the affected industries; the available levels are low because government regulations disallowed the industries to produce at full capacity. We therefore let total investment in the economy decrease by the same amount as GDP (found by iterative simulations) in 2020, while allowing it to move back to the baseline at the same tempo as capital and labour in 2021 and 2022. After 2023 investment demand is determined endogenously by the model.

Household consumption is determined as a fixed proportion of nominal disposable income, given the economy-wide average propensity to consume (APC). In all policy simulations, the economy-wide APC is exogenous. By assumption, real public consumption follows household consumption in the policy simulation.

The model explains changes in relative prices, but has no mechanism to determine the absolute price level. Thus, one price must be exogenous. This price is the benchmark against which all other prices are measured. In the simulations, the numeraire is the nominal exchange rate.

UPGEM contains many variables to allow for shifts in technology and household preferences. In the policy scenarios, most of these variables are exogenous and have the same values as in the baseline projection.

3.2.2 Simulated Shocks for 2020

After the first reported case of COVID-19 the Government of South Africa declared a national state of disaster, published in Government Gazette No. 43096 on 15 March, 2020. The Department of Co-operative Governance and Traditional Affairs subsequently devised five levels of regulations, based on “steps necessary to prevent an escalation of the disaster or to alleviate, contain and minimise the effects of the disaster” (South Africa, 2020).

We calculated the weighted average capacity at which each industry could operate for the year 2020, using the lengths of time that each of the five Levels would last. We had the dates for Levels 2-5 and assumed that Level 1 would last for 6 weeks – the same length as Level 2. The proportions of the year of each Level is given in Table 2.

Table 2. Periods of lockdown in South Africa in 2020

No	Level	Number of weeks	Proportion of the year
1	5	5 (27 March-30 April)	9.6%
2	4	4 (1-31 May)	7.7%
3	3	11 (1 June-17 August)	21.2%
4	2	6 (18 August-29 September)	11.5%
5	1	6 (assumption)	11.5%
6	0	20 (remaining number of weeks)	38.5%
7	Total	52	100.0%

Source: South Africa (2020).

Statistics South Africa (StatsSA) published monthly data until the end of July 2020 on industry output (StatsSA, 2020f). The various Levels coincided with calendar months remarkably well, so that we could map the published data with the effects of the respective lockdown levels. The capacity at which each individual industry in our model could operate was calculated and presented in Table 6 below, as described here:

Agriculture, Forestry and Fishing

Only food-related agriculture, livestock, transport of live animals and auctions (subject to health directions) and related agricultural services were allowed to operate during Level 5; all fishing, operation of fish hatcheries and fish farms were operational, but no forestry activities were allowed. During Level 4 all agriculture, hunting, forestry, fishing and related services, including the export of agricultural products were allowed. However, data that became available about the second quarter of 2020 showed that the lockdown measures had almost no negative effect on the output by the agriculture, forestry and fishing industries. We therefore do not apply any shocks to these industries in the policy simulation, that is, we assume their capacity to produce was not affected.

Mining

During Level 5, coal production for Eskom, the national electricity provider, was allowed. These coal mines could also gradually scale up to full employment. All other mining activities could start in batches, scaling up towards 50% employment. Under Level 4, coal mining was fully operational, open-cast mining could scale up to full employment, while all other mining remained on 50% employment.

For the mining group of industries, we implement published data from StatsSA (StatsSA, 2020c). The year-on-year mining statistics from StatsSA are presented in Table 3 below. The first four rows are numbers from StatsSA, while the last two rows were calculated by the authors from the StatsSA data, using the weights of total mining production given.5

Table 3. Year-on-year percentage changes in the volume of mining production by mineral groups and minerals

No	Mineral group and mineral	Apr-20	May-20	Jun-20	Jul-20
1	Gold	−60.7	−21.2	−16.6	−10.2
2	PGMs	−68.5	−23.1	−41.6	4.6
3	Coal	−10.4	−10.1	−10.9	−8.5
4	Total	−51.3	−25.9	−27.2	−9.1
5	Other mining	−23.8	−13.6	−12.4	−6.4
6	Gold and PGMS	−65.2	−22.3	−31.2	−1.6

Source: StatsSA (2020c) Table 6, p. 7.

To determine the average capacity at which the different mining industries could operate during 2020, we calculated the weighted average of the respective row numbers in Table 3, using the weights in the third column of Table 2. Since both June and July fell in Level 3, plus part of August, for which no data were available at the time of writing this article, we used a weighted average of the numbers for June and July, while assuming that the 2 weeks in August would have the same year-on-year percent changes as July. All mining operations were opened up during Level 2 and hence, it was possible to calculate the weighted average capacities for 2020 (See Table 6).

Manufacturing

StatsSA also published year-on-year data for manufacturing industries (StatsSA, 2020b) and we used the data in a similar way as described above to calculate the weighted average capacity at which each individual manufacturing industry could operate at for 2020. The major groups of industries' data are reproduced in Table 4 below, to give the reader a perspective of the enormity of the lockdown effects on manufacturing in South Africa. StatsSA published the sub-group data as well and we calculated the weighted average capacity utilisation for each manufacturing industry as we have done for the mining industries above. We present the final results in Table 6 below.

Table 4. Year-on-year percentage change in the volume of manufacturing production by division and major group

No	Manufacturing division and major group	Apr-20	May-20	Jun-20
1	Food and beverages	−19.3	−21.0	−11.4
2	Textiles, clothing, leather and footwear	−76.3	−43.4	−16.9
3	Wood, paper, publishing and printing	−48.8	−33.4	−24.5
4	Petroleum, chemical products, rubber and plastic products	−40.6	−27.3	−2.2
5	Glass and non-metallic mineral products	−82.5	−55.9	−22.3
6	Basic iron and steel, non-ferrous metal products, metal products and machinery	−66.0	−33.6	−19.6
7	Electrical machinery	−66.6	−31.8	−20.5
8	Radio, television and communication apparatus and professional equipment	−68.1	−24.4	−4.7
9	Motor vehicles, parts and accessories and other transport equipment	−97.9	−62.0	−38.8
10	Furniture and other manufacturing	−84.4	−58.2	−46.0
11	Total	−49.3	−32.4	−16.3

Source: StatsSA (2020b), Table 5, p. 9.

Wholesale, Retail and Motor Vehicle Trade

StatsSA published three separate documents, containing actual data for wholesale, retail and motor vehicle trade, respectively, from January to July 2020 (StatsSA, 2020h, 2020i, 2020j). Since July and the first half of August both fell into Level 3, we assume the same percentage decrease during the first half of August as during July. Our estimate of capacity utilisation for wholesale, retail and motor vehicle trade for 2020 is, therefore, calculated from published StatsSA data and our estimate is 92.3%.

Hotels, Restaurants and the Tourism Industry

We believe that this industry would be the hardest hit of all industries and assume that they would lose *at least* 6 months' worth of their normal production of services in 2020. Restaurants were closed before the lockdown period and remained closed or partially closed until the end of Level 3. International travel came to a standstill at the beginning of lockdown and would probably remain very quiet in the near future. These types of activities are planned well in advance and after the threat of the virus has dissipated it will take much time before the industry runs on all cylinders again. This industry will only become fully operational during Level 0 of lockdown regulations, after the COVID-19 crisis has subsided. We let the industry lay idle for 30% of the time in 2020. This number is completely in line with StatsSA data that have been published recently (StatsSA, 2020g).

Construction Services

The construction industry was only operational to a limited extent during Levels 4 and 5 of lockdown and moved closer to normal during Level 3. We used StatsSA's statistical release P5041.1 (Selected building statistics of the private sector as reported by local government institutions) (StatsSA, 2020k) to determine the capacity at which the construction industry would probably operate on during 2020. According to Table C in the said document the real value of recorded building plans passed (at constant 2015 prices) decreased by 46.6% during January to July 2020 compared with January to July 2019, while Table G showed that the real value of buildings reported as completed (at constant 2015 prices) decreased by 57.5% during January to July 2020 compared with January to July 2019. If the industry were able to recover and complete the same value of buildings in real terms during August to December 2020, as in the previous year, the annual decrease would amount to 26.56%. We therefore assume that the Construction industry would be able to operate at an average level of 73.4% during 2020.

Financial Services

All financial and insurance services, as well as post and communication services were allowed to operate during all levels of lockdown, so we assume that their capacity for 2020 was 100%.

Some Non-Financial Services

No data have become available for transport services, business services, private services, education or real estate services. Table 5 shows the allowed capacity of operations for each service under the different Levels, according to various Government Gazettes (South Africa, 2020). The Gazettes were not very clear on exactly how much each industry would be

allowed to operate, so that we had to make assumptions for each level. We used the proportions of the year from Table 2 above and multiplied them with the assumed percentages for each industry, to find the average capacities in the last column on the right.

Table 5. Calculated average capacity for some non-financial service industries during 2020

No	Industry	Level 5	Level 4	Level 3	Level 2	Level 1	Level 0	Average capacity
1	Transport Services	50	60	70	80	90	100	82.31
2	Real Estate	25	50	80	100	100	100	84.71
3	Business and private services	90	90	90	100	100	100	96.15
4	Education	50	60	70	80	90	100	82.31
5	Health & Social Services	100	110	120	125	125	100	110.77

Source: Authors' assumptions and calculations.

Health Services

The initial reason for the severe lockdown regulations was to get hospitals ready for many patients who would contract the virus. Temporary makeshift hospital wards were constructed and the industry worked overtime to provide for large increases in the demand for their services. We assume that this industry would operate above its normal capacity according to the percentages in Table 5 above, with a weighted average capacity of 10.77% above normal. How could the health and social services industry in practice operate above the normal level of capacity? They could hire more labour and let workers work overtime, while also increasing the number of beds available to patients. The government imported hundreds of ventilators and other equipment and thereby expanded the industry's capacity.

All the calculated average capacities for the 40 industries in our model are presented in Table 6.

Table 6. Calculated maximum capacity at which each industry in South Africa could operate at during 2020

No	Industry	Capacity (%)	No	Industry	Capacity (%)
1	Agriculture	98.0	21	Other Metal Equipment	85.2
2	Forestry	90.0	22	Electric Machinery	85.2
3	Fishing	100.0	23	Radio and TV	85.2
4	Coal mining	98.0	24	Transport Equipment	87.0
5	Open mining	95.0	25	Furniture	85.2
6	Deep mining	92.0	26	Other Manufacturing	87.2
7	Electricity	100.0	27	Construction	73.4
8	Water	100.0	28	Retail Trade	92.3
9	Food	97.4	29	Wholesale Trade	92.3
10	Beverages and Tobacco	92.0	30	Tourism	86.2
11	Textiles and footwear	88.0	31	Transport Services	88.6
12	Wood Paper Pulp	96.3	32	Post and Telecommunication Services	99.6
13	Printing and Publishing	96.3	33	Finance Service	100.0
14	Petroleum and Refineries	100.0	34	Insurance Service	100.0
15	Chemicals	93.5	35	Real Estate	89.5
16	Rubber	85.2	36	Other Business	96.0
17	Plastic	100.0	37	General Government	96.3
18	Glass	100.0	38	Education	93.5
19	Cement	87.0	39	Health and Social Service	100.6
20	Iron and Steel	85.2	40	Private services	92.6

Source: Authors' calculations from previous tables.

After determining the capacity at which each industry in South Africa was allowed to operate during the various levels of lockdown and subsequently finding the average capacity by industry, we calculated the joint capacity of all industries. Levels 5, 4 and 3 were only in effect for 38.5% of the year 2020, after which time most industries could return back to full capacity. We calculated that on average all industries could operate at 91.1% of their capacity. We therefore decreased total employment in the model by 8.9%, to match the decrease in capital utilisation, in 2020. We do not make assumptions about labour by industry and allow workers to migrate between industries. We therefore only assume that overall employment decreases (nationally) and let the model decide how the employment in each industry would adjust.

Investment Demand

The final shock that we applied to the model was to decrease total investment by 9.6% for 2020. StatsSA published the growth rates in expenditure on GDP and found that gross fixed capital formation decreased by 25.9% during the second quarter of 2020 and by 15.9% during the first half of 2020 (StatsSA, 2020a). We therefore let investment demand decrease by the same amount as real GDP in 2020.

3.2.3 Simulated Shocks for 2021 and Beyond

We assume that the South African economy is set to recover from 2021 onwards. We restore 90% of all industries' capacity in terms of capital and labour utilisation back to the baseline economy in 2021 and the remainder in 2022. We also make very optimistic assumptions about investment and restore 90% of the lost investment demand in 2021 and the remainder in 2022.

4 RESULTS

Depending on the risk of spreading the COVID-19 virus and the adverse effects sick persons would have on the health system of the country, the Government allowed some industries to operate almost fully (*e.g.* coal mines), some partially (*e.g.* transport industry) and some not at all (*e.g.* some private services). Industries whose labourers could work from home could be more productive than industries with large numbers of unemployed workers.

Below, we present some industry-level and macroeconomic results of the impact of the lockdown regulations in 2020 and the recovery path from 2021 onwards. Since the shocks were applied directly to individual industries, we present the industry results first. The macroeconomic results would be dependent on what happens to industries.

4.1 Industry Results

The respective industry results are related to the capacities they were allowed to operate at in 2020 when the period of time that an industry could not produce directly impacted on its annual output. The twelve worst hit industries in 2020 are given in Fig. 1 below, with their respective decreases in outputs, given as percentages below the baseline.

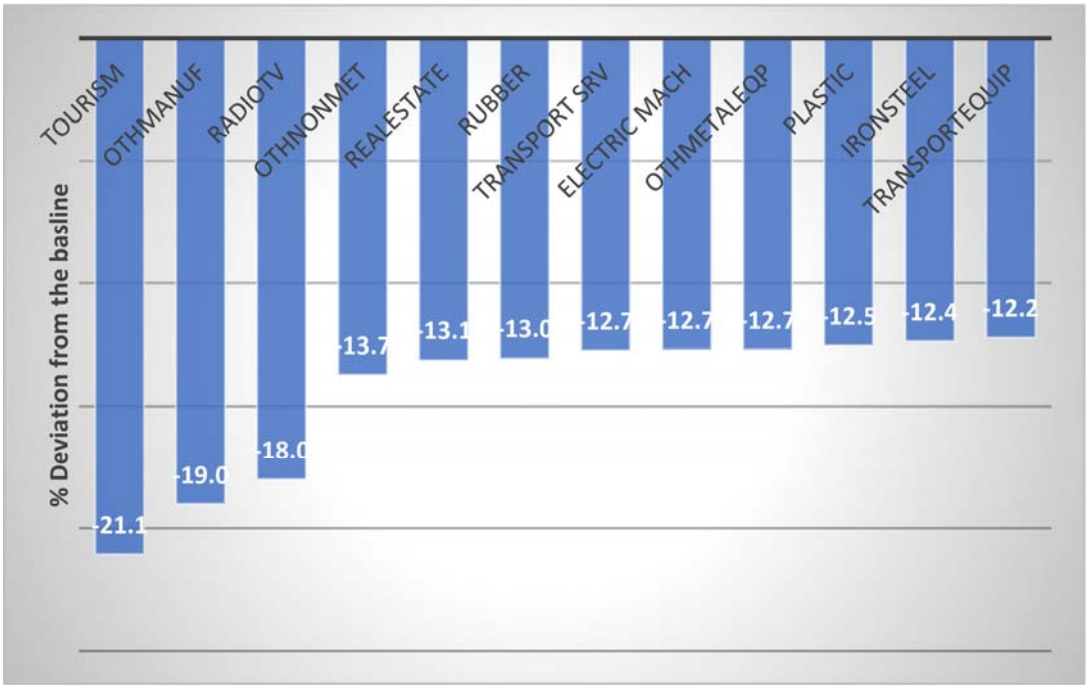

Figure 1. Percentage deviation below the baseline in industry output in 2020

The tourism industry is hit the hardest, by far, and its output will decrease to 21% below the baseline. Although domestic travel started to recover after Level 2, little foreign travel is expected during the rest of 2020. Other manufacturing is the runner up amongst the losing set of industries, producing 19% below the baseline in 2020. The alarming fact coming from Fig. 1 is that nine of the twelve worst hit industries in 2020 are manufacturing industries. Many of these industries were completely closed during Level 5, and allowed to only marginally start operating during Level 4. Transport services is strongly related to the tourism industry and it is not surprising that it lists amongst the worst hit industries.

A very alarming list of industries, however, is the bottom ten in output in 2027 – at the end of our forecast period. Table 7 shows these ten industries with the percentage deviation below the baseline in 2027.

Table 7. Ten worst affected industries by 2027

No	Industry	% deviation from baseline
1	Radio & TV Equipment	−2.35
2	Other Mining	−1.02
3	Electricity and Gas	−1.01
4	Other Metal Equipment	−0.97
5	Basic Chemicals & nuclear fuel	−0.97
6	Basic Iron & Steel	−0.91
7	Rubber	−0.91
8	Other Manufacturing	−0.83
9	Mining of Gold and Metal Ores	−0.81
10	Tourism	−0.81

Source: Model results.

Amongst the worst performers is the electricity industry, whose capacity to produce was not changed in the policy simulation. Its appearance on the list is, therefore, purely a result of decreased demand for electricity in the economy.

One alarming feature of the list in Table 7 is that a few of the South African mining industries appear in the list of worst performers in 2027, even though we have applied modest capacity shocks to them in 2020. The reasons for this are twofold: (i) exports are not doing well in 2027 and the mining industry is exporting much of its output and (ii) mining buys much from the manufacturing industries as intermediate goods and manufacturing is not performing well.

The majority of the industries on the list in Table 7 are still manufacturing industries, who were also the worst hit in 2020.

4.2 Macroeconomic Results

Fig. 2 shows the percentage decrease in capacity that we imposed on all industries and the resulting commodity price changes for the output of the respective industries. As expected, there is a strong inverse relationship between the size of the decrease in capacity and the increase in the respective commodity price. Since we model the slowdown in the various industries by idle capital stocks, accompanied by a decrease in national labour demand, we severely restrict economic output from the supply side. Commodities become scarce to all the usual buyers thereof and price indices increase significantly. The GDP expenditure variables react accordingly, depending on each of their respective price indices.

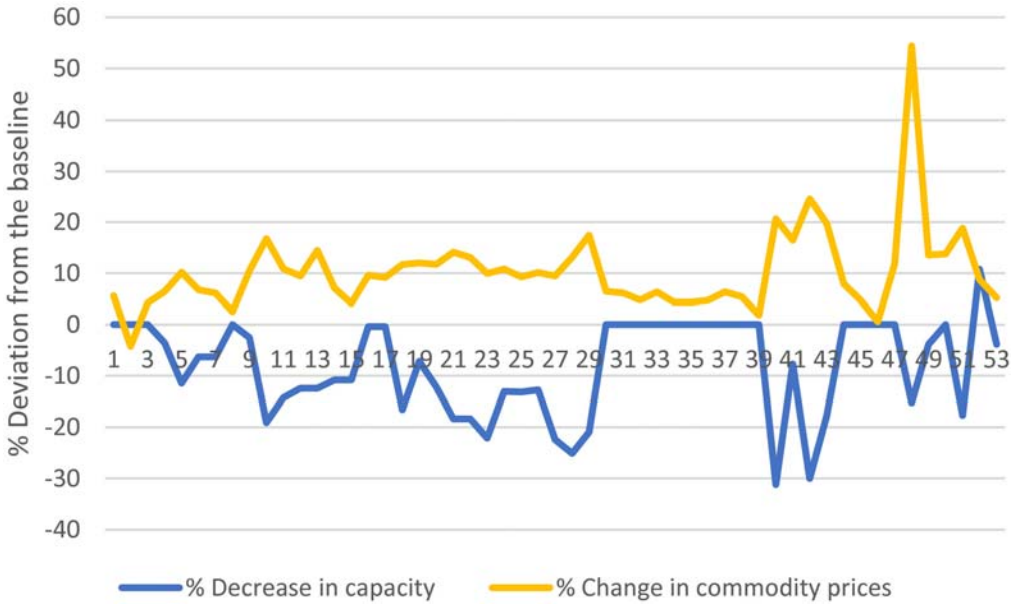

Figure 2. Capacity shocks versus Commodity price changes in 2020

The macroeconomic results are weighted averages of the industry results: for example, aggregate household demand is a weighted average of the household's demand of all the respective commodities in the model, and each quantity demanded is a function of the commodity price. If the weighted average of all commodity prices in the household's basket increases less than the weighted average of all commodity prices in investors' consumption basket, then, total household demand in that year will increase more than investment demand.

The respective price increases in 2020, as depicted in Fig. 2, therefore, drive all the macro results in 2020. Similarly, commodity prices also drive the macroeconomic results in subsequent years. We let all industries return to normal capacity by the end of 2022 and see that prices and the GDP expenditure variables also return towards the baseline. The GDP expenditure results are shown in Fig. 3 below. One of the expected results is that the real GDP of South Africa would decrease by almost 10% in 2020, which is similar to many economic forecasts.

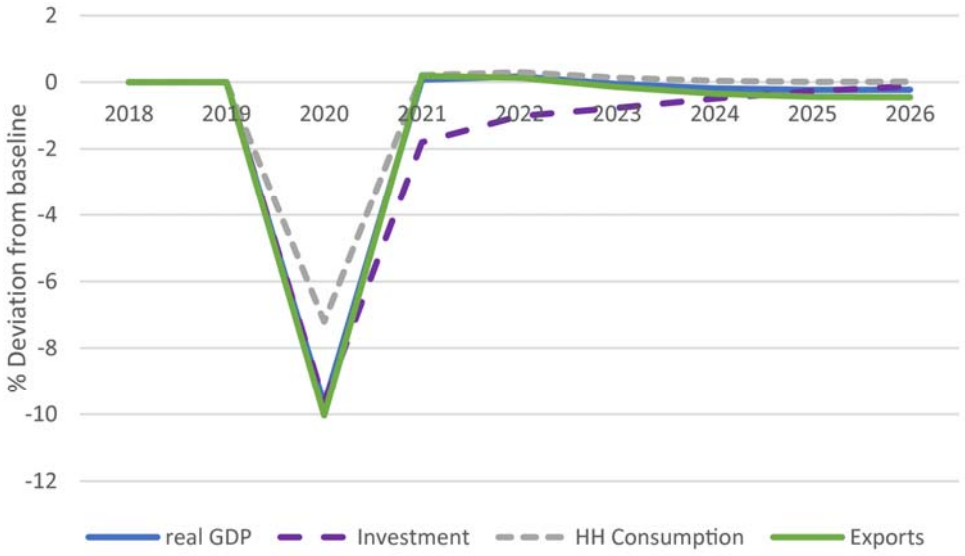

Figure 3. Percentage deviation from the baseline in GDP components on the expenditure side

Fig. 3 shows that all GDP expenditure variables show a V-shaped pattern of decline, followed by an immediate recovery towards the baseline in 2021. This is a result of the fact that we assume that all industries that were affected in 2020 would recover to 90% of their normal capacity in 2021 and to full capacity in 2022. Exports overshoots the baseline level in 2021, which is an unrealistic model result, purely as a result of relative prices between South Africa and the rest of the world.

Results from Table 8 show that in 2021 and 2022 real private and public consumption increase by 0.21% and 0.3% above the baseline forecast value, respectively, whilst total investment decreases to 1.8% and 1.01% below the baseline in the same period. Increases in consumption are usually regarded as welfare gains, but how could the lengthy lockdown period be good news for the economy by leading to welfare gains in the macro economy? If we look deeper we find that there are no welfare gains. The answer lies in the relative changes in the investment and consumer price indices. The investment price index decreases by less than the consumer price index. South Africans are assumed to spend a fixed proportion of their nominal income on consumption and save the rest. To determine the real values of consumption and saving the nominal values are divided by the price indices described above, and if the investment price index is larger than the consumer price index, then, the real value of saving will decrease relative to the real value of consumption. What looks like a welfare gain when real consumption is increasing in 2021 is actually bad news for South Africa: we are delving into our savings to buy consumption goods in the short run

(2 years). From 2023 onwards household consumption converges back to the baseline. Investment expenditure reaches the baseline in 2027 from below.

Table 8. Percentage deviation from the baseline in the GDP expenditure variables

	2020	2021	2022	2023	2024	2025	2026	2027
Real GDP	−9.70	0.08	0.17	−0.05	−0.19	−0.23	−0.23	−0.19
Investment	−9.64	−1.80	−1.01	−0.77	−0.49	−0.27	−0.12	−0.02
Household Consumption	−7.20	0.21	0.30	0.13	0.04	0.01	0.02	0.04
Exports	−10.03	0.19	0.13	−0.14	−0.34	−0.44	−0.45	−0.42

Source: Model results.

Export demand also over reacts in 2021 by moving above the baseline for two periods, as a result of a relative decrease in South African price levels relative to the rest of the world, but then falls below the baseline for the remainder of the forecast period.

5 CONCLUSION

The economic effects of the lockdown period in South Africa have proven to be devastating in 2020. While writing this paper the lockdown was still ongoing and it was uncertain how long it would still continue. However, we believe that the economy would recover very fast and that the recession would be short-term and that all industry and macroeconomic variables could be depicted by V-shaped curves. The economy would return to full capacity soon and return to the baseline.

Industries that suffered and would continue to suffer are the hospitality and tourism industry and all industries related to it, such as transport services, food, beverages and tobacco. Manufacturing in general was also hard hit because they were prohibited to let large groups of labourers enter their premises for extended periods of time. The model shows that most manufacturing would suffer throughout the forecast period, which had been modelled up to 2027.

An alarming result from the modelling exercise was that the mining industries were not harmed much in the very short run, but that they proved to be slow in the recovery towards the baseline. This was because they were heavily dependent on intermediate inputs from the manufacturing industries.

The policy implications for the government are at least twofold. (i) They should allow the economy to recover to full capacity as soon as possible. Restricting any industry has ripple effects throughout the economy: even though the mining industries, for example, were allowed to operate close to full capacity, they were significantly harmed by the regulations on manufacturing and the construction industry. Looking back at the government's response to the pandemic it is clear that they have overplayed their hands completely by locking down the economy too much. (ii) The government should implement expenditure strategies that would support the recovery process of industries in the next few years. We assumed that industries would return to 90% of their capacity in 2021 and that they would also employ up to 90% of their levels of labour that they had in 2020. However, the model simulates what the market would do after 2021. The lockdown periods changed employment patterns: many persons started working from home and could continue to do so in future. Less office space

could be needed in future, so that the need for cleaning and other services might change - some increasing and some decreasing. Many types of jobs might become redundant.

It is not the government's responsibility to create jobs, but the way they spend tax payers' money could make a difference in job creation. If they continue to spend the bulk of their revenue on unproductive government official salaries, they do not contribute towards job creation. However, if they would rather invest an appropriate proportion of the revenue in public infrastructure development, construction companies could hire labour and create jobs.

Some limitations of this study are that we have made the standard assumptions that South Africa is a small open economy that could not influence world prices, that is, that world prices would remain unchanged. The implication of this assumption here is that we ignore any effects that the pandemic would have on the rest of the world and only report negative effects for South Africa.

Future research could utilise more detailed data, as it becomes available and estimate industry and macroeconomic effects more accurately. It would also add much value to add shocks to the world economy from the demand side as soon as data become available.

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