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LINKAGE BETWEEN GOVERNMENTS' COVID-19 RESPONSE MEASURES, REAL EXCHANGE RATE AND PRICES OF WHEAT AND MAIZE IN SOUTH AFRICA

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Abstract

The outbreak of Covid-19 disease caused disruption in global supply chains as countries imposed various measures in a bid to contain the coronavirus. This paper examines the nexus between governments' Covid-19 response measures, real exchange rate and prices of wheat and maize in South Africa. We used daily data (February 07 - September 25, 2020) for the stringency index obtained from Our World Data, import parity and South African Futures Exchange (SAFEX) prices of maize and wheat. We considered South Africa's major suppliers of wheat and maize, i.e., Argentina, Germany and the United States (US). Maize was disaggregated into two categories, namely: white and yellow maize. Both descriptive and Pearson's correlation analyses were used to establish the nexus. Findings suggest that Covid-19 response measures are associated with the observed depreciation of South Africa's Rand against the US Dollar and the spikes in SAFEX prices of wheat and maize. Furthermore, results reveal a moderate to strong positive relationship between South Africa's real exchange rate and the prices of wheat and maize. However, increases in wheat and maize prices were borne by consumers as exhibited in higher retail prices that were observed in South Africa between February and September 2020, but wheat prices were the most affected. Results further reveal that there is a strong nexus between the levels of strictness imposed by the different countries, thereby implying that imposition of very strict measures in one country also tends to spur imposition of equally strict measures against Covid-19 in other countries. The significance of the results in minimising the impact of Covid-19 outbreak is twofold. First, countries may consider revisiting the kind of restrictive response measures they put in place as these measures affect supply chains in other countries. Second, South Africa's need to diversify the sources from which she imports the major grains – maize and wheat.

Key words: Food price inflation; Grain South Africa; Import parity price; National Agricultural Marketing Council; SAFEX price; South African Grain Information Service

1. Introduction

Since November 2019, the outbreak of coronavirus responsible for the disease known as Covid-19 is ravaging a number of countries, irrespective of whether a country is regarded as developed or not. In the interest of ensuring that their citizens are food secure, a number of countries imposed various response measures, including lockdowns (Reardon et al., 2020) coupled with temporary trade restrictions on a number of agricultural products, entailing cereals, fruits and vegetables. Covid-19 outbreak occurred at a critical time amid a raging global oil-price war between Russia and other oil producers, while on the other hand China and the United States (US) were battling in trade wars. All these shocks compounded the strain on the global systems, including agriculture, financial, health and trade sectors. The straining situation inevitably spilled to disrupt global supply chains, hence the worst recession since the Great Depression as reported by the International Monetary Fund (IMF) (2020).

The spread of Covid-19, fluctuating exchange rate and the oil-price war have been noted to be key drivers of commodity prices although it is still early to ascertain the full impact the pandemic shall have on the global economy. However, the National Agricultural Marketing Council (NAMC) (2021) associated the higher food price inflation (4%) in 2020 when compared to 3.1% food inflation of 2019 to an increase in meat prices and other food products rather than the Covid-19 pandemic. In South Africa, as President Cyril Ramaphosa declared a national state of disaster on 16th March 2020, thereby imposing restrictions on schools and borders among other measures in a bid to contain the spread of the disease, the Africa All-Share Index at Johannesburg Stock Exchange (JSE) dropped by 12%, the biggest decline ever since August 2013 (ENCA, 2020). At the same time, the Rand lost value by 2.2% against the United States (US) Dollar, thereby trading at R16.64. At the time, South Africa's economy was also internally struggling due to power shortages, the unsustainable national carrier- the South African Airways and the weak business confidence, among factors. Hence, the president indicated that

"*It is going to have a negative impact on our economy, our economy which is already in technical recession".*

In response to the Covid-19 pandemic, many sectors within the economy with the exception of agriculture to a great extent reduced their activities to a bare minimum. Activities within the agricultural sector were generally permitted to go on smoothly to ensure continued production and supply of food as the sector is considered as an essential service. However, South Africa imposed restrictions on the sale, distribution and consumption of some non-essential products, including alcoholic beverages and tobacco products which are directly linked to primary agricultural products like wine grapes, barley and tobacco. Due to the backward and forward linkages in the sector the ban on the sale, distribution and consumption of alcoholic beverages was reported to not only affect the wine and beer industries but also other value chain actors including tavern owners, restaurateurs and firms that make packaging materials like glass bottles and cans. The wine industry reckoned that the ban on local sales during levels 5 and 4 of the lockdown resulted in losing more than 20% of market share, translating into revenue losses of over R4.5 billion and the industry shed over 18 000 jobs (Basson, 2020; Biz Community, 2020; Mashego, 2020). Notably, over time the restriction on the sale, distribution and consumption of alcoholic beverages was relaxed on conditions that distributors and consumers adhered to certain regulations.

Beyond South Africa, some countries including Russia, Colombia, Oman, Nigeria and the Eurasian Economic Union imposed temporary trade measures on wheat and maize. This presents a unique case for South Africa to scrutinise the nexus between the pandemic, real exchange rate and the price of wheat and maize. It is important to note that maize and wheat are very critical commodities in South Africa's staple foods basket. According to a 2020 report by the United States Department of Agriculture (USDA), South Africa's annual per capita consumption of maize was estimated at 90 kilograms (kg) per person while wheat stood at 55 kg per person (USDA, 2020). A 2021 report by the South African Grain Information Services (SAGIS) indicated that annual wheat consumption in South Africa increased by 41.6% from 2.4 million tons in 2000/01 to 3.4 million tons in 2019/20. South Africa is net importer of wheat but a net exporter of maize.

According to the South African supply and demand estimates report of August 2020, the total supply of white maize during the 2020/21 marketing season was estimated at 9.27 million tons while yellow maize was projected at about 6.67 million tons. On the other hand, the total supply of wheat during the same marketing season was projected at 3.98 million tons. South Africa projected to export 1.17 million tons and 1.37 million tons of white and yellow maize, respectively but with zero imports for both types of maize. For wheat, South Africa anticipated to import about 1.7 million tons while exports were projected at 0.135 million during the 2020/21 marketing season (NAMC, 2020a).

Therefore, it is against this background that this paper aimed at establishing the nexus between governments' strictness during lockdown in response to the pandemic, exchange rate and the prices of wheat and maize in South Africa. This paper contributes to the existing body of knowledge as follows: First, we assess the evolving impact of COVID-19 response measures, as measured by the stringency index, on prices of the major grains in South Africa by comparing the percentage change in prices during the different levels of stringency measures used. Second, we explore how the exchange rate fluctuates as South Africa's major suppliers of maize and wheat impose various COVID-19 response measures. Third, our findings may provide insights for policy makers within South Africa and other countries into how to strike a balance between imposing very restrictive COVID-19 response measures and sustaining continuity of economic activities during this unprecedented time of the pandemic.

2. Literature review

There is a fast-growing body of anecdotal evidence on the impact of Covid-19 pandemic on agriculture and food system in South Africa but little empirical work has so far been done to substantiate on this. Therefore, the reviewed literature focuses on the agricultural sector and the food system at large, entailing both anecdotal evidence and empirical studies. Broadly, the imposed measures in response to the pandemic significantly disrupted the agri-food supply chains. Due to the restrictions on the movement of people, disruptions were more eminent at the food processing, distribution, retailing and consumption stages along the supply chain (HSRC, 2020).

At the primary production phase, there was minimal disruption since most activities are mechanised amongst the large-scale farmers. However, in the case of the smallholder farmers, disruptions arose as labourers could not easily go to farms because of the restrictions during lockdown level 5. Furthermore, at the time (March 2020) when lockdown measures were imposed in South Africa, most summer crops (wheat and maize inclusive) had almost reached the harvesting stage, hence there was a negligible effect. Based on secondary data obtained from SAGIS, the volume of white maize delivered by producers was slightly below the usual average when compared with the deliveries during recent years. This suggests that the disruptions due to the covid-19 pandemic had minimal effect on the quantities of white maize delivered by farmers.

During the weeks early into the lockdown, the demand of basic food items increased due to panic buying as consumers were very much uncertain how long the lockdown would last, thereby spurring a spike in prices. For instance, disruptions led to short term shortages of cereal products including maize meal in retail shops in some parts of the country (Business Insider, 2020; Deliotte, 2020). However, by late June 2020, the prices of some basic food items had dropped back to almost the pre-Covid-19 situation while the volume of processed white maize had increased by over 10% as compared to the volume processed in May 2020. According to SAGIS data, more white maize was processed in March 2020 possibly due to the high demand in preparation for the lockdown but during the subsequent months, the quantities processed dropped. This was possibly due to the hard lockdown during which movement was highly restricted, coupled with the requirement that travellers (employees in this case) had to present a travel permit which could not be issued to some workers during level 5 of the national lockdown.

Based on data obtained from Statistics South Africa (Stats SA) (2020a) and using the year 2015 as a baseline, the food manufacturing and beverages industry registered a drastic drop in the volume of food and beverages manufactured during the hard lockdown in April 2020. However, as the lockdown measures were eased in the subsequent months, the volumes processed rose again. Similarly, in comparison to 2019 and the other years, data from Stats SA revealed that production capacity in the food industry was below the average in 2020 (specifically during the first two quarters) and this was attributed to the low demand. For instance, the low demand for non-alcoholic drinks was attributed to the restricting of the hospitality industry from trading, while keeping in mind that a total ban on the sale, distribution and consumption of alcoholic drinks had also been imposed during the level 5 of the lockdown.

Pertaining to trade, as the fear of contagion increased among the people and in some instances, employees testing positive for Covid-19 at food retail stores coupled with fewer customers visiting the outlets, some shops closed down (Business Insider, 2020a; 2020b). This not only affected the quantities of agricultural products sold but also contributed to the rise in the price of basic staple food items given the uncertainty of the extent of damage the pandemic would cause. According to NAMC (2020b) and Stats SA (2020b), prices of basic food items were greatly affected by the pandemic and imposed lockdown measures. For instance, between February and June of 2020, the price of rice increased by 51% while the price of a 2.5 kilogram (kg) wheat-based cake flour increased by 17%.

Similar increases in many other food items were observed at the start of the lockdown period but as the country eased some of the restrictive measures in June and the subsequent months, prices of some products were seen to decline. For instance, from February to April the price of stewing beef had increased by 20% but by May and June prices declined by 3% and 7%, respectively while between February and June, the price of eggs greatly varied with a 58% increase in April and then an 18% drop in May (NAMC, 2020b; Stats SA, 2020b). Also, during the same period some countries including Vietnam, and those ascribing to the Eurasian Economic Commission (EEU) started to imposed temporary trade measures (e.g., export bans) on food items (ITC, 2020). The Bureau for Food and Agricultural Policy (BFAP) (2020) reported that a large proportion of South Africans could hardly afford a basic healthy food basket due to the high prices of food items and this was largely attributed to the outbreak of the pandemic.

3. Methodology

3.1. Data

The study used daily data spanning from February 07th up to September 25th for the year 2020, with the exception of weekends and public holidays during which the JSE does not operate. The analysis took into consideration of Argentina (Arg), Germany (Germ.) and the United States (US) which are the major suppliers of wheat while in the case of maize, the analysis was based on Argentina and the US. Maize was disaggregated into two categories, namely: white and yellow maize. In South Africa, yellow maize (YMZ) is mostly used for animal feeds while white maize (WMZ) is for human consumption. Two types of prices for wheat and maize *i.e.*, import parity price and SAFEX price obtained from Grain South Africa (Grain SA) were used. Grain SA is a commodity body responsible for providing strategic support and services to the South African grain sector.

Import parity price refers to the price payable by a purchaser for imported goods and it constitutes the cost, insurance and freight (c.i.f.) import price plus tariff and the transport cost to a purchaser's location. Import parity prices were only available for wheat sourced from the US, Argentina and Germany while for maize, available data was for yellow maize (YMZ) sourced from the US and Argentina. White maize (YMZ) is sourced from the US, thus the only available import price data. SAFEX price on the other hand is the price of a good at a given time as at the South African Futures Exchange, a subsidiary of the JSE. A stringency index extracted from Our World in Data (2020) was used as the yard stick to measure any government's strictness during the different phases of the lockdown, based on the various response measures to employed to curb the pandemic. The index ranges between 1 and 100, whereby one (1) is the least strict level and 100 is the strictest. Daily real exchange rate data was obtained from the South African Reserve Bank (SARB) (2021).

3.2. Data Analysis

To establish the nexus between governments' strictness during lockdown, exchange rate and the price of wheat and maize, descriptive analysis and Pearson's correlation analysis were used. Correlation analysis, was used to test the strength of the relationship between there variables. A significantly high positive correlation coefficient for any variables under consideration means that there is a direct strong relationship with each other while a low positive coefficient signifies that there hardly exists any direct relationship. Conversely, a significant negative sign irrespective of the size of the coefficient implies that there exists an inverse relationship.

Following Yang et al. (2021) Pearson's correlation analysis was undertaken based on the following generic model.

$$r = \left(\frac{\sum(x_{i-}\bar{x})(y_{i-}\bar{y})}{\sqrt{\sum(x_{i-}\bar{x})^2 \sum(y_{i-}\bar{y})^2}} \right)$$

Where r denotes correlation coefficient, x_i represents either of the variables (stringency index, exchange rate or price) in the sample, $\bar{x}$ is the mean value of either of the above stated variables, y_i represents the value of either of the above stated variables in the sample while $\bar{y}$ is the mean value of either of the above stated variables the sample. Given that the analysis entails three variables, the statement "*the value of either of the above stated variables*" implies that variables change depending on the linkages being analysed (See Table 1).

Table 1: Definition of variables.

Variable	Definition	Source
Exchange Rate	South Africa's daily real exchange rate against US Dollar (US$)	South African Reserve bank
Index South Africa	Stringency index for South Africa	Our World in Data
Index US	Stringency index for United States (US)	Our World in Data
Index Argentina	Stringency index for Argentina	Our World in Data
Index Germany	Stringency index for Germany	Our World in Data
SAFEX YMZ	SAFEX price for yellow maize at Randfontein (R/ton)	Grain SA
YMZ parity US	Import parity price for yellow maize from US (R/ton)	Grain SA
YMZ parity Argentina	Import parity price for yellow maize from Argentina (R/ton)	Grain SA
SAFEX WMZ	SAFEX price for white maize at Randfontein (R/ton)	Grain SA
WMZ parity US	Import parity price for white maize from US (R/ton)	Grain SA
SAFEX Wheat	SAFEX price for wheat at Randfontein (R/ton)	Grain SA
Wheat parity US	Import parity price for wheat from US (R/ton)	Grain SA
Wheat parity Argentina	Import parity price for wheat from Argentina (R/ton)	Grain SA
Wheat parity Germany	Import parity price for wheat from Germany (R/ton)	Grain SA

4. Results and Discussion

4.1. Descriptive statistics

Summary statistics for South Africa's Rand against the US Dollar (US$) and the stringency index for South Africa (SA), Argentina (Arg.), Germany and the United States (US) are presented in **Table 2**. Between February and late September of 2020, the exchange rate was on average R17.10 per US Dollar. During the same period, Argentina imposed the strictest response measures with a mean index of 78.24, followed by South Africa (66.62) while Germany imposed the least strict measures (54.87).

Table 2: Summary statistics for exchange rate and stringency index (07 February - 25 September, 2020).

Description	Exchange rate (R/US$)	South Africa Index	US Index	Argentina Index	Germany Index
Mean	17.10	66.62	60.15	78.24	54.87
Standard Deviation	1.04	28.19	22.07	29.95	18.63
Minimum	14.76	2.78	5.56	11.11	5.56
Maximum	19.08	87.96	72.69	100.00	76.85
Sample size (n)	165	165	165	165	165

Sources: Authors' computation based on data extracted from Our World in Data (2020) and South Africa Reserve bank (2021)

Table 3 presents descriptive statistics pertaining to prices of wheat and maize in South Africa. The mean import parity price for white maize (R4 090/tonne) imported from the US was higher than the import parity prices of yellow maize imported from either the US (R3 990/tonne) or Argentina (R3 860/tonne), hence the higher SAFEX price of white maize when compared with that of yellow maize. The higher price of white maize was attributable to high demand of food items at the start of the lockdown given that it is used for human consumption unlike yellow maize which is used in the manufacturing of animal feeds as reported by Business Insider (2020) and HSRC (2020). The import parity price of yellow maize sourced from the US is attributable to the depreciation of the Rand against the US Dollar, hence the high SAFEX price of yellow maize in South Africa.

Table 3: Summary statistics for wheat and maize prices (07 February - 25 September, 2020).

Description	Maize price (R'000/tonne)				
	Yellow Maize			White Maize	
	Import Parity		SAFEX	Import Parity	SAFEX
	US	Argentina		US	
Mean	3.99	3.86	2.74	4.09	2.87
Standard Deviation	0.20	0.20	0.20	0.48	0.37
Minimum	3.64	3.27	2.45	3.43	2.36
Maximum	4.60	4.49	3.31	5.06	5.06

Description	Wheat price (R'000/tonne)			
	US	Argentina	Germany	SAFEX
Mean	5.63	5.83	5.48	5.35
Standard Deviation	0.32	0.22	0.27	0.38
Minimum	5.12	5.38	4.99	4.70
Maximum	6.41	6.39	6.09	6.41

Sources: Authors' computation based on data extracted from Grain SA (2020)
Note**:** Sample size (n) for each series was 165 observations

However, based on the descriptive statistics presented above while taking cognisant of the fact that countries were imposing various covid-19 response measures during the different levels of lockdowns, critical information relevant for the better understanding of the nexus between the strictness of lockdown measures and the prices of wheat and maize is masked. Thus, graphical illustrations from the periods during which fluctuations in prices and strictness occurred are discussed below. **Figure 1** shows the trends for the SAFEX price and import parity price of wheat and the corresponding stringency index for South Africa (SA), Argentina (Arg.), Germany (Germ.) and the United States (US) between early February and late September, 2020.

It was observed that all the mentioned countries started imposing very strict Covid-19 response measures during the first two weeks of March, 2020. By March 26th, all countries had drastically become very strict to the extent that Argentina attained the strictest level (index = 100) while SA, US and Germany were at 88.0, 72.3 and 76.9, respectively.

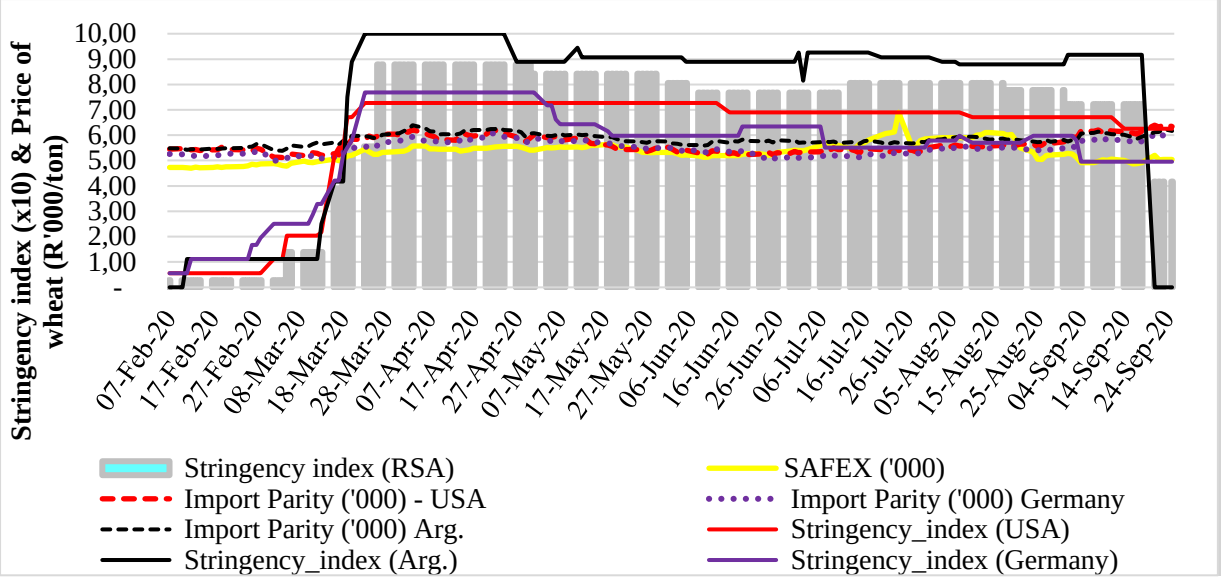

Fig. 1. Strictness by governments during Covid-19 pandemic lockdown and wheat prices
Source: Authors' compilation based on data extracted from Grain SA (2020) and Our World in Data (2020)

The onset of strict lockdown measures in South Africa and in other countries coincided with the depreciation in value of the Rand against the US Dollar (See: Annex 1), thereby suggesting a possible nexus between the two as well as the prices of wheat and maize. However, even when government response measures stabilised in South Africa e.g., between March 26th and April 30th, the exchange rate was erratic. From **Figure 1**, five timeframes with distinct changes in governments' strictness towards containing the pandemic were in part used as the basis to establish the linkage with prices (**Table 4**).

Table 4: Effect of governments' strictness during lockdown on wheat prices in South Africa.

Time Frame	Change in strictness during lockdown				Change in SAFEX price	Change in import parity prices		
	SA	US	Arg.	Germ.	SA	US	Arg.	Germ.
March 05th – 25th	300%	257%	800%	207%	9.8%	13.9%	7.6%	8.8%
May 01st – 30th	0.0%	0.0%	2.1%	-22.3%	-1.8%	-9.0%	-5.2%	-6.9%
July 13th - Aug 10th	0.0%	0.0%	-5.0%	3.4%	7.8%	2.4%	3.7%	6.7%
Aug 10th – 31st	-3.5%	0.0%	0.0%	4.9%	-11.0%	3.1%	-2.2%	-0.8%
Sept. 01st -25th	-42%	-6.9%	-100%	-17.0%	-4.5%	8.9%	7.2%	8.8%

Source: Authors' computation based on data extracted from Grain SA (2020), Our World in Data (2020)
Note: Arg. denotes Argentina, SA represents South Africa, US stands for United States of America and Germ. stands for Germany. In some instances, the selected dates also coincide with periods during which South Africa's exchange rate showed large fluctuations.

Between March 05th and 25th, all the four countries registered significantly high levels of strictness with Argentina recording a 800% increase, followed by South Africa (300%), US (257%) and Germany (207%). Correspondingly, the SAFEX price of wheat at Randfontein in South Africa also increased by 9.8% within the same time frame. This increase was largely driven by a 13.9% increase in the import parity price of wheat sourced from the US, followed by Germany (8.8%) and Argentina (7.6%). For the month of May, South Africa's and the US's levels of strictness remained constant at 84.26 and 72.69, respectively. Conversely, Argentina became stricter by 2.1% (from 88.89 to 90.74) while Germany's stringency reduced by 22.3% from 76.85 (01 May) to 59.72 (30 May). Overall, these changes in strictness during the lockdown can be linked to the 1.8% drop in the SAFEX price of wheat, but largely being driven by declines in the import parity prices of wheat from the US (9.0%), Germany (6.9%) and Argentina (5.2%).

During the third phase (July 13th – August 10th), stringency levels of South Africa (80.56) and US (68.98) did not fluctuate while Argentina's declined by 5% and Germany's increased by 3.4% but the exchange rate fluctuated considerably. The SAFEX price of wheat increased by 7.8% (to R5 899 per ton as of August 10th) and this was largely driven by a 6.7% increase in the import parity price of wheat from Germany, Argentina (3.7%) and the US (2.4%). In September, most countries gradually lifted a number of lockdown restrictions. For instance, Argentina's stringency index of zero indicates that during this period it was completely out of the lockdown. The relaxation of lockdown measures in a number of countries may be attributable to a decline of 4.5% in South Africa's SAFEX price of wheat despite an increase in import parity prices for the countries supplying wheat to South Africa as the Rand depreciated further. This implies that strictness of lockdown had a direct effect on SAFEX wheat prices.

In the case of maize, import parity prices available were for the US and Argentina. The trends for the maize prices plotted along with various levels of strictness are shown in **Figure 2**. Similarly, although slightly different from the case wheat, five time-frames (See **Table 5**) were also used to assess how maize prices were affected by the various levels of strictness imposed during the lockdowns.

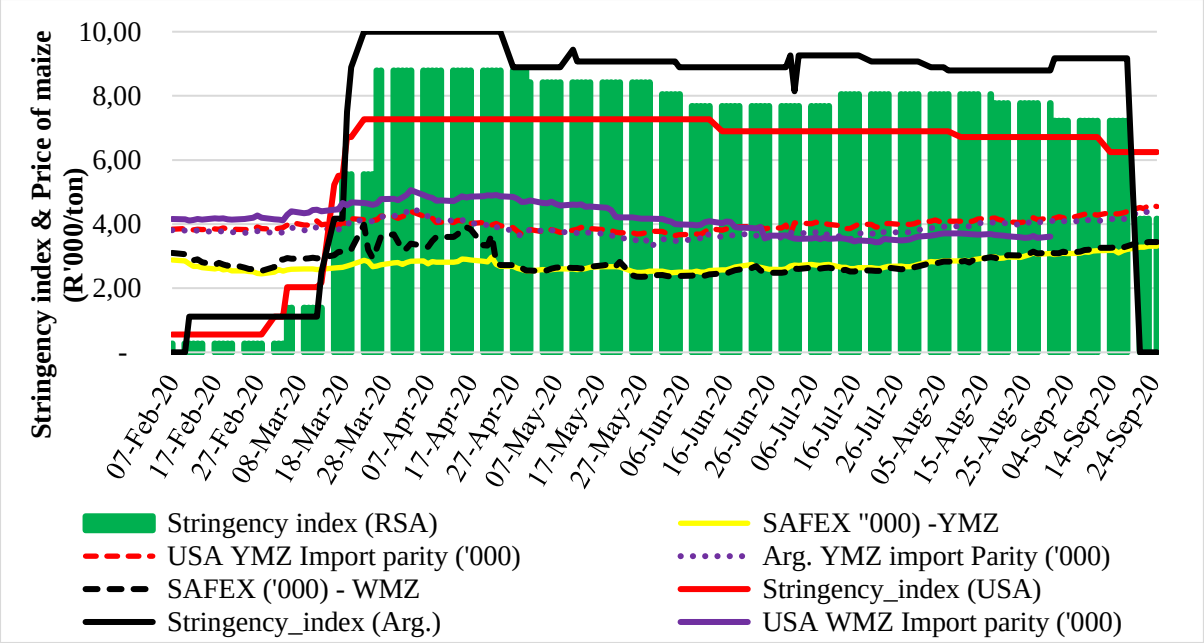

Fig. 2. Strictness by governments during Covid-19 pandemic lockdown and maize prices
Note: WMZ stands for White maize, YMZ represents Yellow maize.
Source: Authors' compilation based on data extracted from Grain SA (2020), Our World in Data (2020)

During the time-frame of March 02nd – 23rd, South Africa recorded the highest and most drastic increase in strictness in response to the outbreak of the pandemic, followed by Argentina and the US. During this period, South Africa's stringency index rose to 55.56 from a mere 2.78 (an equivalent of a 1 899% increase) while the Rand depreciated by 15% from R15.53 per US$ to R17.81 per US$. White maize was the most affected unlike yellow maize. SAFEX prices for maize rose by 49.4% in the case of white maize (WMZ) and 14.9% for yellow maize (YMZ). Due to the depreciation of the rand, the increase in WMZ SAFEX price was largely driven by a 12.4% upsurge of import parity prices of WMZ from US while YMZ SAFEX prices were mostly influenced by a rise in import parity prices of YMZ from Argentina. Thereafter, the SAFEX price of WMZ fluctuated significantly and was much higher than the SAFEX price of YMZ. However, import parity prices for YMZ from Argentina and US showed little variations. This suggests that the strictness of the lockdown in Argentina and the US had a more direct impact on WMZ than YMZ.

Table 5: Effect of stringency during lockdown on maize prices in South Africa.

Time frame	Change in strictness during lockdown			Change in SAFEX prices		Change in import parity prices		
				South Africa		US		Arg.
	SA	US	Arg.	WMZ	YMZ	WMZ	YMZ	YMZ
March 02nd – 23rd	1 899%	554%	800%	49.4%	14.9%	12.4%	8.0%	10.7%
Apr. 22nd - May 22nd	-4.2%	0.0%	-9.3%	-22.9%	-10.4%	-13.8%	-6.0%	-7.8%
May 25th - Aug 10th	-4.4%	-7.6%	-3.1%	17.5%	13.0%	-11.7%	9.6%	10.6%
Jun 12th - Aug 10th	4.8%	-7.6%	-1.0%	16.5%	11.7%	-9.2%	60.3%	7.5%
Aug 10th – 31st	-3.5%	0.0%	0.0%	10.3%	8.0%	-2.8%	2.5%	4.5%
Sept. 01st -25th	-42.3%	-6.9%	-100%	11.2%	8.6%	0.7%	8.9%	6.2%

Source: Authors' computation based on data extracted from Grain SA (2020), Our World in Data (2020)

Note: Arg. denotes Argentina, US denotes United States of America, SA represents South Africa, WMZ represents white maize and YMZ denotes yellow maize.

For the second time frame (April 22nd – May 22nd), as South Africa and Argentina relaxed the strictness during the lockdowns while the US remained at 72.99 level, the value of the Rand against the US Dollar appreciated by 6%. This led to the drop in maize prices ranging from 7.8% for Argentina's import parity prices of YMZ to 22.9% for the SAFEX price of WMZ. The large decline in the SAFEX price of WMZ was driven by a drop in import parity prices of maize from the US due to the stability in the country's strictness in response to the pandemic. Within South Africa, the decline may be attributable to the consistent assurance by various institutions in the agricultural sector that there was adequate stock of WMZ coupled with forecasted bumper harvest for the ongoing production season (Reuters, 2020; Wandile, 2020), and appreciation of the Rand against the US Dollar. According to the Crop Estimate Committee, by mid-2020 maize harvest had been forecasted to be more than 15.5 million tons, an equivalent of almost 37% higher than the harvest of 2019 season, and WMZ was noted to be the key driver of the overall bumper harvest of the 2020 season (BFAP, 2020).

Between May 25th and August 10th, the SAFEX price for YMZ slightly increased above that of WMZ. This was largely driven by import parity prices of YMZ from the US which increased by 60.3% between June 12th and August 10th while the import parity price for WMZ from the US had recorded a decline despite the more stringent measures that had been imposed in Argentina (See **Figure 2**). Notably, the Rand was appreciating during this time frame, thus suggesting that the situation in the US played a critical role in influencing the import parity

prices of YMZ and WMZ. During September, many countries lifted a number of restrictions that had been imposed during the lockdowns and the exchange rate fluctuated drastically.

4.2. Correlation analysis

The correlation results presented in **Table 6** suggest that there are is a strong significant and positive relationship between exchange rate and the level of stringency imposed in each country. For instance, the significant correlation coefficient of 0.811 ($p < 0.05$) exhibited by South Africa means that imposing very strict Covid-19 response measures, hence a high stringency index tends to foster depreciation of the Rand against the US Dollar. Similarly, the results reveal a moderate to strong positive relationship between South Africa's real exchange rate and the prices of wheat and maize. Wheat prices are the most affected, especially for that imported from Argentina. The strong and significantly positive correlation coefficient of 0.802 ($p < 0.05$) implies that as South Africa's Rand depreciated against the US Dollar, the import parity price of wheat sourced from Argentina also tended to increase by 0.802 proportions, followed by Germany and the US.

Prices for white maize (WMZ) were found to be weakly associated with the exchange rate while for yellow maize, it was only the import parity prices for maize sourced from Argentina that exhibited a weak but statistically significant correlation coefficient (0.154, $p < 0.05$). The weak linkage between the Rand and maize prices was attributable to the fact that South Africa is generally a net exporter of maize, coupled with the fact that the crop estimate committee had forecasted a bumper harvest for the season, hence there was no need to panic (BFAP, 2020). However, for the fact that South Africa imports a significant proportion of wheat (42.5%) in relation to the total demand (NAMC, 2020c), the depreciation of the Rand against the US Dollar inevitably renders wheat to be more expensive.

Results further reveal there is a strong nexus between the levels of strictness imposed by the different countries, thereby implying that imposition of very strict measures in one country also tends to spur imposition of equally strict measures against Covid-19 in other countries. It is worthwhile to note the correlation coefficients for the stringency index between all countries were above 0.910 ($p < 0.05$). With regard to linkage between wheat and maize prices, there is no statistically significant correlation between SAFEX prices of the two grains. However, results reveal that there was a low to moderate significant positive relationship between the import parity prices of wheat and maize, depending on the country of origin.

Table 6: Results based on the Pearson's correlation analysis.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Exchange Rate	1.000													
Index South Africa	0.811*	1.000												
Index US	0.799*	0.966*	1.000											
Index Argentina	0.767*	0.950*	0.975*	1.000										
Index Germany	0.903*	0.914*	0.927*	0.908*	1.000									
SAFEX YMZ	0.065	0.163*	0.222*	0.327*	0.139	1.000								
YMZ parity US	0.039	0.081	0.158*	0.248*	0.143	0.849*	1.000							
YMZ parity Argentina	0.154*	0.045	0.096	0.187*	0.189*	0.774*	0.890*	1.000						
SAFEX WMZ	0.173*	-0.002	0.039	0.117	0.176*	0.686*	0.711*	0.845*	1.000					
WMZ parity US	0.468*	-0.009	-0.033	-0.076	0.253*	-0.331*	-0.21*	0.134	0.302*	1.000				
SAFEX Wheat	0.566*	0.685*	0.638*	0.619*	0.583*	0.001	0.036	-0.047	-0.142	-0.134	1.000			
Wheat parity US	0.463*	0.324*	0.358*	0.458*	0.426*	0.671*	0.645*	0.761*	0.666*	0.277*	0.024	1.000		
Wheat parity Argentina	0.802*	0.627*	0.644*	0.689*	0.735*	0.477*	0.506*	0.594*	0.519*	0.373*	0.340*	0.847*	1.000	
Wheat parity Germany	0.661*	0.466*	0.472*	0.531*	0.548*	0.476*	0.406*	0.567*	0.507*	0.431*	0.144	0.906*	0.891*	1.000

Source: Authors' compilation based on data extracted from Grain SA (2020), Our World in Data (2020)
Note: * Significant at 5%; WMZ stands for White maize, YMZ represents Yellow maize, parity refers to import parity price and Index refers to stringency index for different countries.
Source: Authors' compilation based on data extracted from Grain SA (2020), Our World in Data (2020)

4.3 Discussion

The increase in SAFEX and import parity prices of wheat and maize between February and September, 2020 is attributable to the imposition of very strict lockdown measures by the various governments in a bid to contain the Covid-19 pandemic. In part, due to the strict measures imposed by countries coupled with the junk status rating of the South African economy, the Rand depreciated thereby rendering the soaring of prices of grains (wheat and maize) which are used as food and raw materials in a number of food value chains. Despite that fact that cargo could be transported within South Africa, there was a slowdown of activities and delays at various harbours, thereby distorting the proper logistical operations hence exacerbating the rise in prices of both wheat and maize. Moreover, consumers were uncertain of the extreme implications of the pandemic and many resorted to panic-buying of food stuffs from the stores (BUSINESSTECH, 2020; Viljoen, 2020).

Given that maize and wheat are used as inputs in a number of food products, higher prices translate into higher prices paid by consumers. This school of thought concurs with a report by the National Agricultural Marketing Council (NAMC) (2020b) in which relatively high year-on-year price changes in food items derived from wheat and maize are reported. For instance, in July 2020, the price of a 700 grams loaf of brown bread increased by 6.2%, a 2.5 kg cake flour increased by 16.7% while one kilogram of super maize meal rose by 7.9%, in comparison with prices in July 2019. Yellow maize prices did not have drastic increases as was the case of white maize simply because yellow maize is largely used in the manufacturing of animal feeds and this was indirectly observed through higher meat prices.

5. Conclusion and recommendations

The devastating effects of Covid-19 pandemic are eminent in the various spheres of economies globally. With particular focus on international trade, many countries responded to the pandemic by imposing temporary trade measures on a number of agricultural products, maize and wheat included. Despite the fact that major suppliers (Argentina, US and Germany) of wheat to South Africa did not impose temporary trade measures, other measures imposed in by these economies had indirect effects on the import parity prices in South Africa during the period considered in this paper. As a net exporter of maize, South Africa projected a bumper harvest for the 2020 production season, hence there was little to worry about maize supplies. Stringent Covid-19 response measures imposed by key trading partner countries like the US

and Germany (in the case of wheat), US for white maize and Argentina for yellow maize are associated with significant increase in the prices of wheat and maize in South Africa. In addition, the imposed Covid-19 response measures are associated with the observed depreciation of the Rand against the US Dollar, which affected the import parity prices of wheat and maize.

Therefore, it is prudent to conclude that stringent measures imposed during lockdowns are directly and indirectly associated with the increase in wheat and maize import parity prices, which inevitably affected the corresponding SAFEX prices. These increases are directly passed over to the consumers through higher retail prices that were observed in South Africa between February and September, 2020. Based on the findings, the following recommends are put forward:

i) South Africa should consider diversifying the countries from which to source wheat and maize. This is advantageous given that when the few current suppliers experience shocks, such as the ongoing pandemic, the risk of those countries imposing trade restrictive control measures that culminate into price spikes would be minimised.

ii) In the event of global shocks such as the Covid-19 pandemic, countries should minimise imposing measures that may not be urgently needed to mitigate the shock. In some instances, the imposed measures are good but may either be misinterpreted or poorly enforced by the concerned institutions at the expense of the intended beneficiaries. It is therefore important to continuously sensitise the masses with regard to the measures in question. Putting in place relevant measures at an apt time frame coupled with continued sensitization of the masses is bound to minimise other undesirable spill- over effects both within and beyond borders of a given country or territory.

iii) In the interest of minimising price spikes for staple food items (e.g., maize) in the near future, farmers should be encouraged and supported to produce more maize (both yellow and white) given that there is much uncertainty about for how long the pandemic will continue ravaging across countries. However, this also implies that more investment in infrastructure (e.g., storage facilities, access roads, … etc) should be made within or nearer to the areas where agricultural production occurs in order to cater for likely increase in production.

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Annex 1

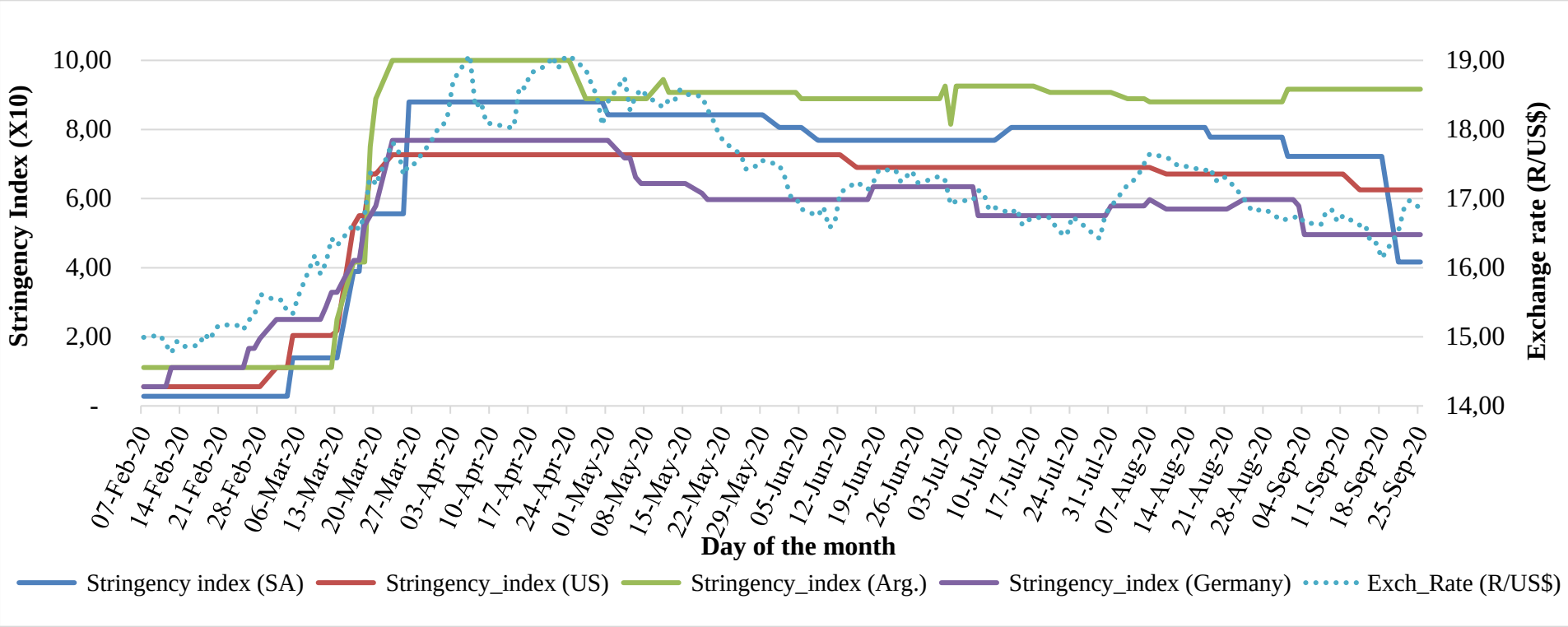

Fig. 3. Strictness by governments during Covid-19 pandemic lockdown and exchange rate

Source: Authors' compilation based on data extracted from Our World in Data (2020) and South African Reserve bank (2021)