



1. INTRODUCTION

The Consumer Price Index (CPI) is designed to measure the average price changes of a fixed basket of consumption goods and services commonly purchased by the resident households over time. It is an important barometer of overall economic health and is widely used in many countries as a proxy for cost of living.

This [Shiny app](#) allows users to study the changes in CPI in Singapore over the past 10 years (2012-2021), and to reveal the impact of the COVID-19 on the cost of living here.

2. METHODOLOGY

The dataset used was the ["Consumer Price Index \(CPI\), 2019 as Base Year, Annual"](#) from Singstat. It contained information ranging from average retail prices of commonly bought items (e.g. bread, eggs, personal effects etc) to the annual Consumer Price Index for 10 main categories of expenditure (e.g. Food, Transport, Communication, Education etc) at the Division level up to January 2022. Only **full year data from 2012 to 2021** was used so as to focus on the impact of COVID-19.

To visualise the changes from different perspectives, the **descriptive analysis** of showed the changes in CPI and price changes for different item divisions/ classes using line charts, box plots, sunburst charts as well as horizon graphs.

Next, **time series, autocorrelation and partial autocorrelation (ACF/PACF) analyses** was conducted between different item divisions, to glean insights to the relationships between the observations and the time lags preceding them. **Seasonality analysis** was also conducted in order to see if certain items experienced cyclical changes over time.

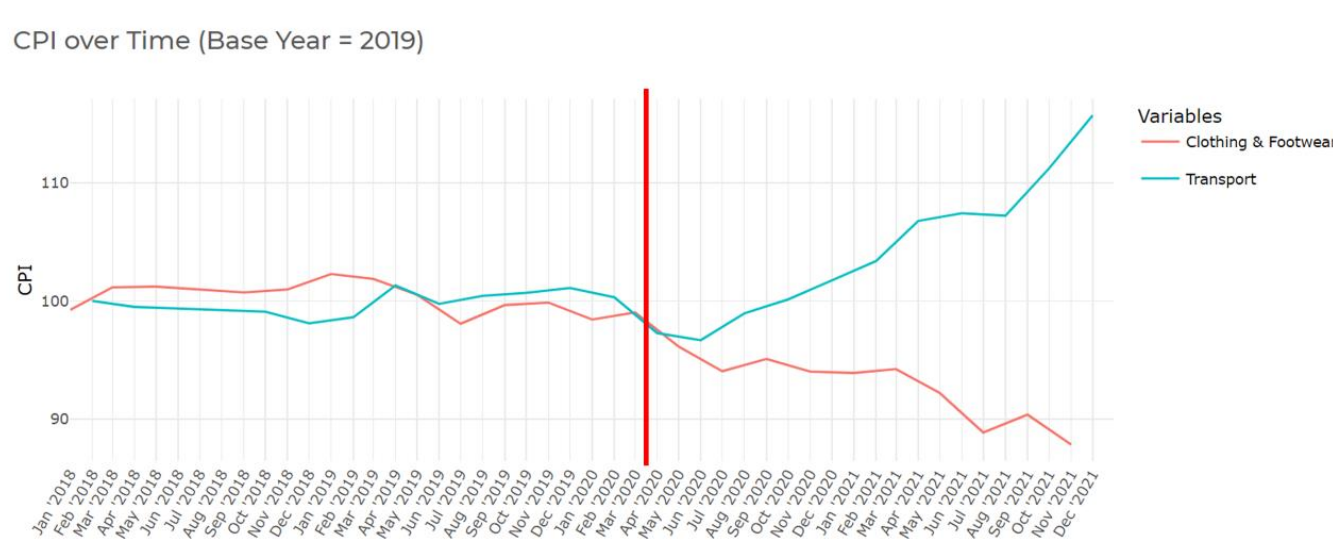
Lastly, **predictive analysis** was conducted on the historical data provided, in order to forecast future price changes in different items. A plethora of models such as **ARIMA, ETS, TSLM and autoregressive models** was employed.

R programming was used for the data processing, statistical analyses and development of the web application. Examples of **packages used** included: *Shiny, shinyWidgets, lubridate, zoo, tsibble, forecast, ggHoriPlot, timetk, DT, tseries, fpp3, ggthemes, plotly, bslib, readxl* and *tidyverse*.

3. RESULTS

3.1 DESCRIPTIVE ANALYSIS

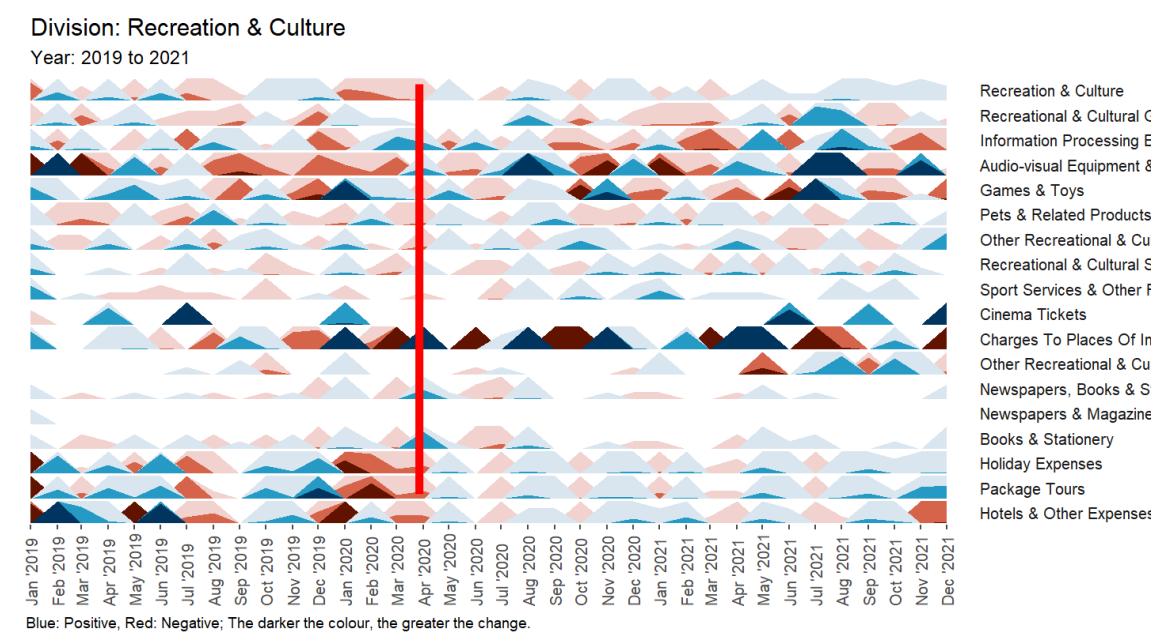
Among all the types goods sold in, the CPIs most impacted by COVID-19 are Transport and Clothing & Footwear. The CPI for transport increase, while clothing & footwear decreased.



As more restrictions were implemented, footfall to physical retailers reduced drastically. This eventually led to a behavioral change in consumers, who had to turn to convenience via online platforms. Reducing the operations of a physical store, retailers can potentially reduce operational cost and price their product competitively by transferring some cost savings to their customers. Digital platforms also enable consumers the ability to compare products from several retailers, and select from a lower price point. Furthermore, consumers may have no incentive to purchase these products as they stay home most of the time. Hence, enabling the cost of clothing & footwear to reduce.

It was unexpected to see such a drastic increase from transport due to the impact on air and public systems. However, upon diving deeper, it was discovered that this rise was mostly contributed by the private motorcycle transport and other transport service excluding air. One reason could be due to the boom in the food delivery services during this period, such that more people are purchasing motorcycles to support their livelihood of doing food deliveries. This demand for motorcycles is further exemplified by the substantial increase in motorcycle Certificate of Entitlement (COE) which has risen by 80% from March 2020 to July 2020 and is still seeing and increasing trend in 2022¹.

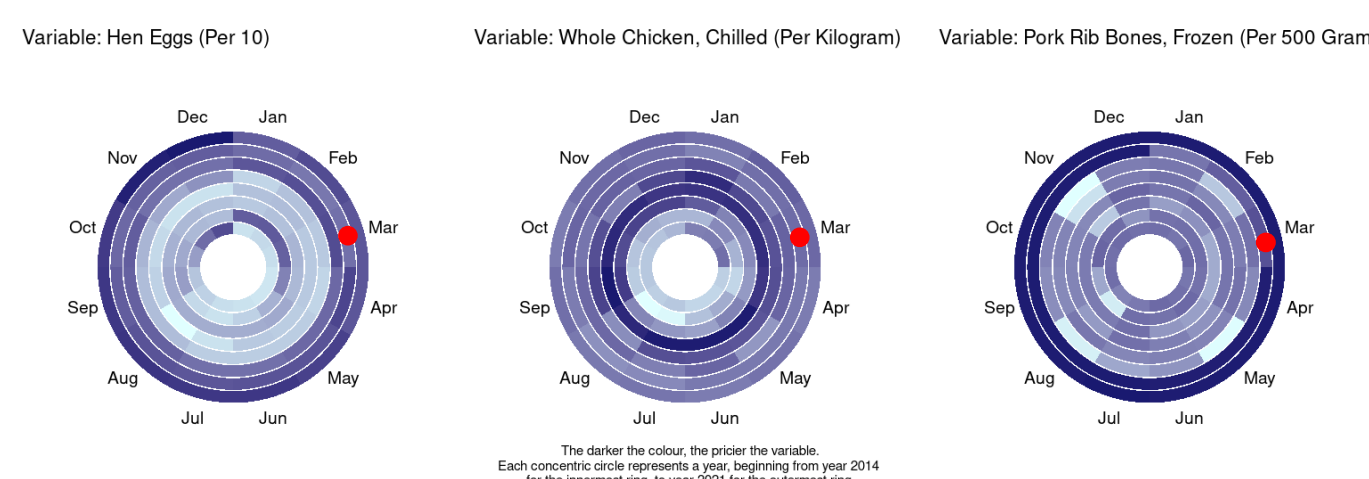
Due to the restrictions implemented, the recreation & culture industry was also notably impacted by COVID-19, especially for tourism sector. The horizon plot below shows the monthly change in CPI of Recreation & Culture goods and services.



From the horizon plot, it is notable that some services such as cinema, sports and holidays were unavailable during the pandemic especially with worldwide border restrictions.

The charges to places of interest had reduced drastically in Mar 2020, as crowds avoided being in close proximity with other people in public places. On the other hand, we observe that CPI of games & toys increased during this period. This may be due to more people seeking them as a form of entertainment they can enjoy at home. Similarly, the CPI of books and stationery started to increase as people may have more time to enjoy leisure reading.

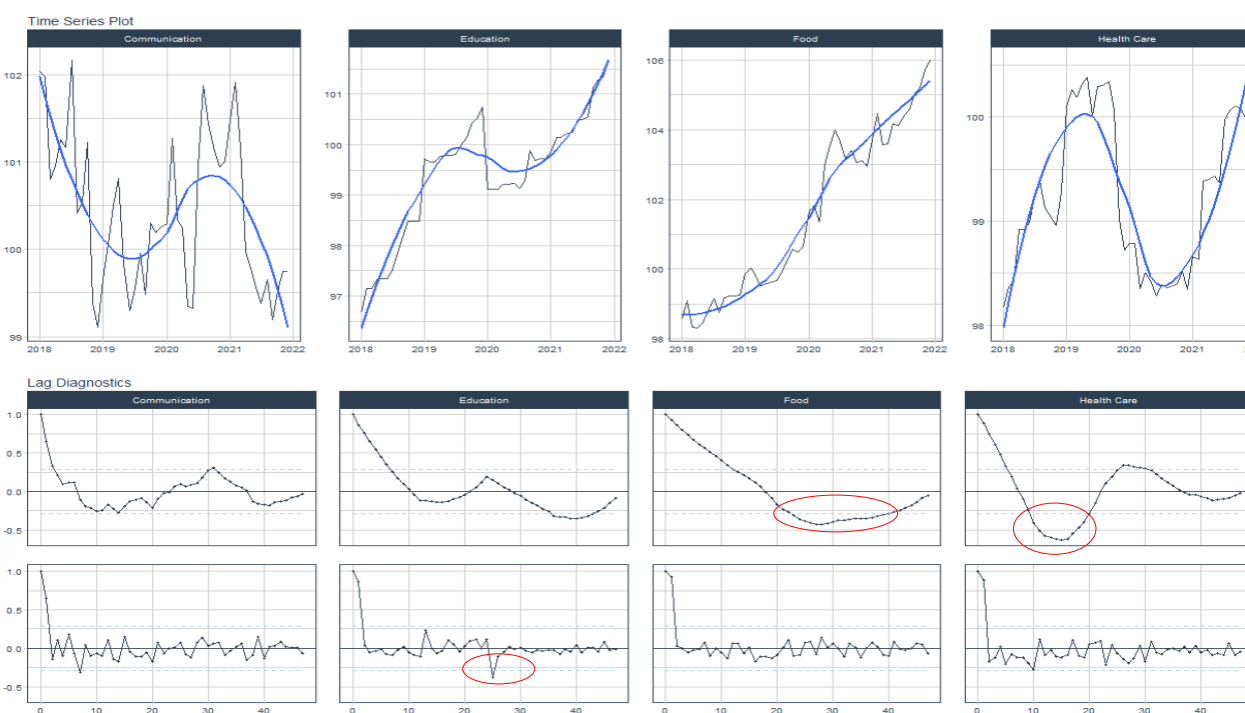
Being dependent on food imports, we are also interested to look at how the food prices in Singapore were affected by the restrictions and supply chain constraints during COVID-19.



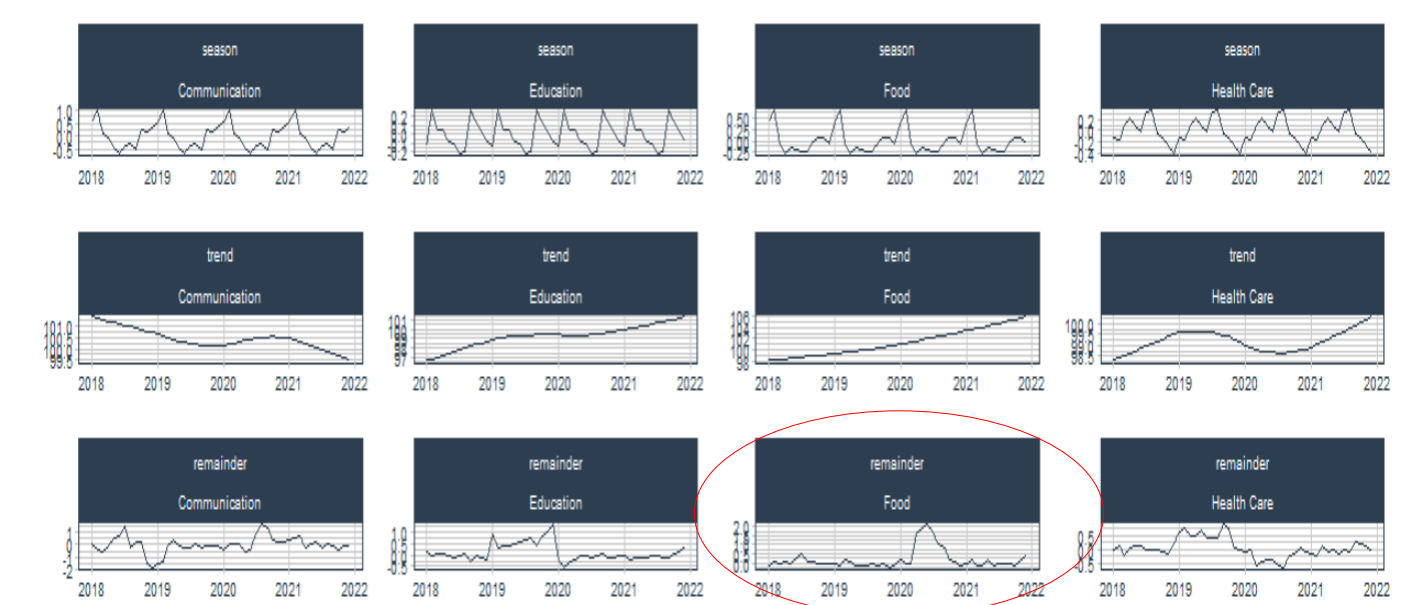
Compared to eggs and chickens, the impact of the prices on frozen pork rib bones seem to be more prominent and affected by COVID-19. This may be due to the different trading partners that our country works with. Singapore imports 74% of its eggs from Malaysia², and over 80% of chicken from Brazil and Malaysia³. Malaysia is Singapore's neighbour and is easily accessible via land. This also means that logistic and transport arrangement can be easily made to ensure the supply chain runs smoothly. To curb unease and panic buying, the Ministry of Trade and Industry even managed to import eggs from Poland for the first time during the pandemic via air freight⁴. On the other hand, chilled and frozen pork is mostly imported from Brazil, Australia, Netherlands and Spain⁵. The locations are much further compared to Malaysia and are likely to be transported via sea. Sea transport generally takes a longer time and are more susceptible to supply chain disruptions as business operations halt or reduce during the pandemic. Hence, potentially causing a bottleneck in the pork supplied, resulting in higher prices.

3.2 ACF/PACF & SEASONABILITY ANALYSIS

Using a 95% confidence threshold and 4 selected divisions, Communication, Education, Food, Healthcare between 2018-2020, we observed that while the time series for Communication was relatively more volatile, there was no statistically significant correlations between monthly time intervals. This was unlike the others e.g. for Education, there was a statistically significant negative spike in the PACF in middle of 2020, possibly affected by the enhanced government subsidies for tertiary education⁶; For Food, a statistically significant negative correlation occurred during 2020-2021. For Healthcare, there was a strong negative correlation in 2019, when government published fee benchmarking⁷. These negative autocorrelations signal a switch in direction of influence between each observation and its preceding one. Interestingly, when the time period was extended to the full dataset, these correlative effects were diluted, with no significant observations across the years.

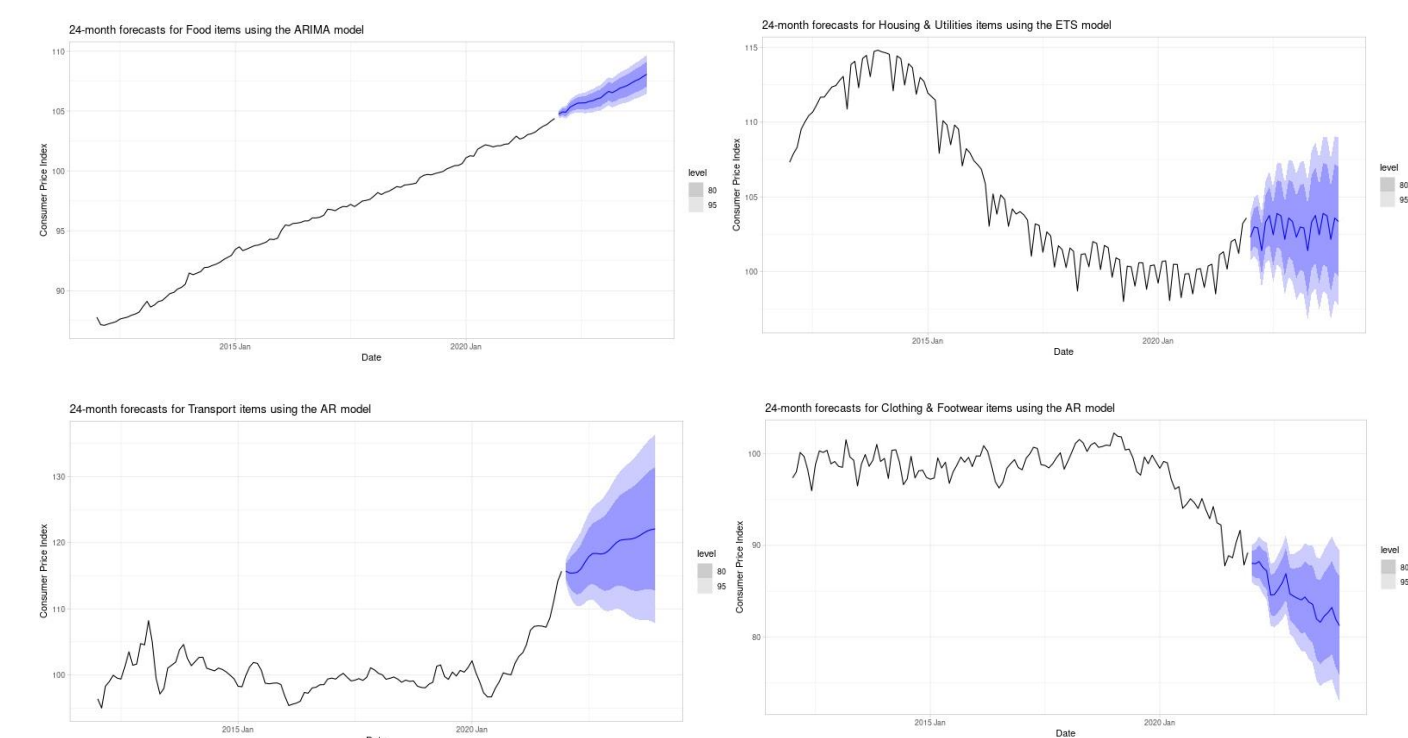


Using STL decomposition, we could see that all divisions had regular, seasonal fluctuations and fairly random residuals but Food saw a spike in residual signal between 2020-2021 that was not attributed to either trend nor season. This was most likely due to the impact of COVID-19.



3.3 PREDICTIVE ANALYSIS

Looking at the overall trend for all items, we can see that the forecast of CPI has a steady uptrend. In a recent news article, it was stated that Singapore's CPI, or overall inflation, to continue rising amidst higher inflation for food and electricity and gas, as well as a slower pace of decline in the cost of retail and other goods.



Based on our forecast models, we can see that for food and transport, the 24-month forecast for CPI is set to increase. Interestingly, the forecast for Housing & Utilities were maintaining or even have a slight decline, together with forecasts for Clothing & Footwear, which is forecasted to have a sharp decline. Considering recent events such as the COVID-19 global pandemic, clothing and footwear retailers, especially brick-and-mortar retailers, had to drastically cut prices⁸ to bring in sales. This could be one possible explanation for the continued decrease in CPI for Clothing and Footwear, which is forecasted to continue.

In a similar vein, the global disruptions to supply caused by the global pandemic has led to bottlenecks in energy and commodities, leading to rapid increases in price. In particular to Food items, the trend has been seeing a steady rate of inflation, over the decade, and is expected to continue to increase further. With the increase in energy prices, we can also expect prices for Transport items to increase as well, such as prices for Petrol. This is backed by our forecasts for Transport, which is expected to continue to rise.

4. FUTURE WORK AND CONCLUSION

Given the on-going war in Ukraine and rising oil and gas tariffs, we expect that there could be further impact to CPI trends in the future. One area for future work for the app could be to allow users to upload updated datasets of more recent CPI results to continue monitoring trends.

We hope that through our app, the general public would be able to keep up-to-date on the latest price changes of various items, as well as use our app to forecast future price changes and make better, informed decisions for their future.

REFERENCES

¹sgbikeparking. (2022, March 9). *Latest Motorcycle COE Bidding Results 2022*. Retrieved from <https://www.sgbikeparking.com/motorcycle-coe/>
²The Observatory of Economic Complexity. (2020). *Eggs in Singapore*. Retrieved from The Observatory of Economic Complexity: <https://oec.world/en/profile/bilateral-product/eggs/reporter/sgp>
³Hirschmann, R. (2021, May 17). *Share of imports of chicken to Singapore in 2019, by country of origin*. Retrieved from Statista: <https://www.statista.com/statistics/1217998/singapore-share-of-imports-of-chicken-by-country-of-origin/>
⁴Website of the Republic of Poland. (2020, June 5). *First imports of eggs from Poland in Singapore*. Retrieved from Website of the Republic of Poland: <https://www.gov.pl/web/singapore/first-imports-of-eggs-from-poland-in-singapore>
⁵TrendEconomy. (2021, November 14). *Singapore | Imports and Exports | World | Meat of swine | Value (US\$) and Value Growth, YoY (%) | 2009 - 2020*. Retrieved from Annual International Trade Statistics by Country (HS02): <https://trendeconomy.com/data/h2/Singapore/0203>
⁶Mahmud, A. H. (2019, August 19). *NDR 2019: Reduced university and polytechnic fees for lower-income students from next academic year*. Retrieved from Channel News Asia: <https://www.channelnewsasia.com/singapore/ndr-2019-lower-university-polytechnic-fees-income-bursaries-866206>
⁷Ministry of Health. (2021, June 15). *FEE BENCHMARKS AND BILL AMOUNT INFORMATION*. Retrieved from Ministry of Health: <https://www.moh.gov.sg/cost-financing/fee-benchmarks-and-bill-amount-information>
⁸Jacob, C. (2021, July 23). *Singapore retailers are reeling from further Covid measures as sales drop 70% for some*. Retrieved from CNBC: <https://www.cnbc.com/2021/07/23/singapore-retailers-reeling-from-covid-measures-as-sales-drop-up-to-70percent.html>