Analytics of Coronavirus Stock Market Crash

Healthcare Data Analytics and Data Mining

Group 1

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Introduction

The U.S. equity market has experienced a dramatic drop in value starting mid-February. The S&P 500 Index, which tracks the stocks of the largest 505 companies in the U.S. and is considered by many as a measure of American economic vitality, has declined from its recent peak 3380 on Feb. 14th to 2237 on Mar. 23th. The rate of dropping is faster than any other market crash in history[1]. It took only 22 trading days for the index to dip by more than 30%. For reference, the second, third and fourth fastest pullbacks of this magnitude all occurred in the Great Depression in the 1930s. During the indiscriminate massive sell-off, the intra-day circuit breaker was triggered four times (total five times in the history since the technique was first introduced in 1987) as a means to prevent the index from falling by more than 7% on a single trading day.

Though the Federal Reserve put in use many drastic measures as a means to reduce the impact of the economic recession, including slicing interest rates to almost zero[2], adding 2.3 trillion dollars to the market and etc., the market did not react until one month later. For reference, during the 2008 financial crisis, the Fed only added 800 billion dollars to the market through quantitative easing[3]. Meanwhile, this is the first time in history that the Federal Reserve started purchasing corporate bonds directly[4].

Now we can see that actions initiated by the Federal Reserve are unprecedented and at a magnitude at least 3 times the measures it took during the 2008 financial crisis. So how come that the U.S. equity market is so vulnerable to Covid-19?

The pandemic, which is believed to be highly contagious, has hit China first, and the Chinese government responded by imposing drastic quarantine measures to ensure the well-being of its citizens. During the time of the quarantine, more than 1 billion people were required to stay at home for more than 3 weeks. As a result, almost all business activities came to a halt. American investors, who have witnessed both the spreading of the virus and the suppression of infection, feared that an exponential growth of infected cases in the U.S. would disrupt the economic activities as well. So, when the number of cases started climbing up in mid-February, panic drove a crazy indiscriminate massive sell-off of all stocks.

Meanwhile, even before the pandemic, it is believed that the equity market after a 10-year bullish run (denoted as the New-Norm Boom by Robert Shiler, the Nobel Prize Laureate) is on the edge of a correction. A bunch of indices that trace both the equity market and the economy.

Indicated that the equity market is overheated. For example, the Buffet indicator[5] suggests that the total market cap has way exceeded American GDP, and every time, the former is above the latter, a market correction will be followed. The Shiller P/E[6] also suggests that the market in general is overpriced by more than 50% of historical average. It should also be noted that during the New-norm boom, the price rose as a result of stock buy-back, not concrete earning increase. A large number of corporations are in heavy debt, and the outbreak of the pandemic hit investors' confidence of their insolvency capabilities.

[1] https://www.cnbc.com/2020/03/23/this-was-the-fastest-30percent-stock-market-decline-ever.html
[2] https://www.marketwatch.com/story/heres-what-the-feds-surprise-interest-rate-cut-means-for-mortgage-rates-2020-03-03
[3] ttps://www.vox.com/2014/6/20/18079946/fed-vs-crisis
[4] https://www.forbes.com/sites/nathanvardi/2020/03/23/the-federal-reserve-moves-to-buy-corporate-debt/#1cce568b4c47
[5] https://www.gurufocus.com/stock-market-valuations.php
[6] https://www.gurufocus.com/shiller-PE.php

In addition, the failure to reach an agreement between the OECD and Russia and a following oil price crash put American oil companies at risk of defaulting and bankruptcies.

During the market crash, some sectors were hit particularly hard while others stayed afloat. In this case study, we would like to examine the difference among sectors to stand still against the market freefall by studying the 11 sectors, which the S&P 500 Index is composed of.

In this assignment, we mainly deal with several topics as follows:

- Sector Trend Movements
- A Deadly Crash in Energy Sector
- Financial Sector Crash
- Dilemma of Health Insurance Companies: Challenge vs. Opportunity
- Cluster Analysis by Value Retention
- Value Retention Distributions in Healthcare Sub-Industries
- Government Rescue Package: Sector Healthcare Becomes A Darling!
- Social Implications of An Uneven Market Crash

Q1: Sector Trend Movements

After we calculated the percent decline and percent value retention (VR), we applied weighted average value retention according to the market capitalization of each company in order to measure the sector performance. Based on our results (Table 1), the weighted VR of Consumer Staples is 76.50%, while the weighted VR of Consumer Discretionary is 68.83%. Consumer Staples sector contains basic necessities such as Packaged Foods & Meats, Soft Drinks, Agricultural Products, etc. These kinds of products have low income elasticity of demand and tend to have a stable price during an economic crisis. On the opposite, Consumer Discretionary including many luxury goods has much lower income elasticity of demand. Therefore, Consumer Staples has the highest weighted VR in our table while Consumer Discretionary shows lower strength in value retention. This observation is consistent with the rules of Income Elasticity of Demand.

GICS Sector	Weighted VR	Average VR	Percentage Decline
Consumer Staples	76.50%	74.53%	-25.47%
Health Care	72.11%	69.89%	-30.11%
Communication Services	70.97%	66.33%	-33.67%
Information Technology	69.34%	66.58%	-33.42%
Consumer Discretionary	68.83%	52.29%	-47.71%
Utilities	63.93%	63.18%	-36.82%
Materials	63.25%	61.32%	-38.68%
Real Estate	60.95%	57.60%	-42.40%
Industrials	57.78%	58.50%	-41.50%
Financials	57.15%	54.69%	-45.31%
Energy	44.29%	39.73%	-60.27%

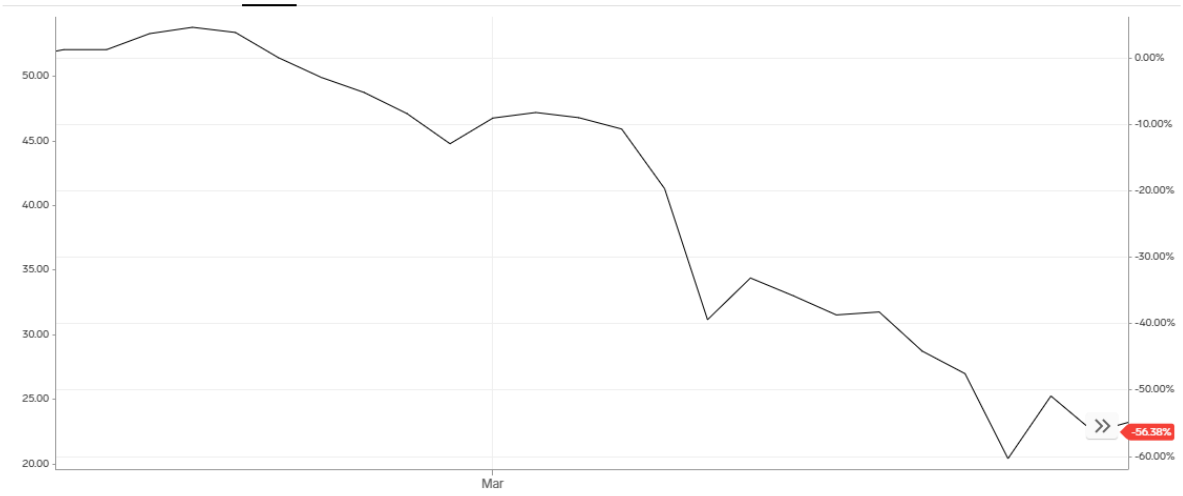
Table 1 Sector Performance

However, the Consumer Discretionary seems more immune in this crisis than some essential sectors like Utilities and Materials. Focusing on the exact average VR, we actually can see that Consumer Discretionary has much lower average VR than the other two sectors. The reason of this inconsistency, in our hypothesis, is that some big companies with large market capital in the Consumer Discretionary sector are relatively immune in Coronavirus pandemics. Digging deeper in our dataset, we found that companies like Amazon and Target had very large Market Cap and high VR in this crisis, where Amazon has the largest Market Cap in Consumer Discretionary sector with high retention value of 89.13%. Similarly, the VR of Target Corp. reached 82.90% with over 59 billion Market Cap. It makes sense because Amazon and Target represent Internet Retail companies, who can continue their business and needless to say more immune to the global quarantines. Therefore, these large companies with high economical immunities contributed a lot to the weighted VR and caused the inconsistency between average VR and weighted VR.

Q2: A Deadly Crash in Energy Sector

It is very obvious that the weighted VR of Energy sector is the lowest and much lower than any other sectors. In Energy sector, most companies' main business is related to oil. Unfortunately, oil price crashed as Arabia and Russia vowed to pump more in a battle for market share. The all-out price war between these two countries caused futures slumped by about 25% at the beginning of March. No oil related companies can hide from these extreme price falls (Figure 1). In particular, explorers including Occidental Petroleum Corp. and Parsley Energy Inc. planning drilling cuts. These passive expectations will lead to a predictive fall of share price. In our case, the VR of Occidental Petroleum is merely 23.29%.

Figure 1 WTI crude price (Feb. 14th – Mar. 23rd)



What's more, the higher cost of producing shale oil makes US companies vulnerable to prolonged price wars. According to consultancy Rystad Energy, just 16 U.S. shale companies operate in fields where the average new well costs are below $35 per barrel. Most of the shale producers had expectations for oil between $55 and $65 per barrel in 2020, so the price fall puts them in a very dangerous point that they will not be able to shoulder their high debt load. Due to these reasons, few investors could be confident in the energy corporations, and it is foreseeable that slumped share price and the shrinkage of retention value.

Q3: Financial Sector Crash

Although it is not as severe as what happened in the energy industry, the financial sector has faced a similar dangerous inability in value retention during these global events. Facing this outside shock, Federal Reserve try to limit damage and promote recovery in several ways. One of the most important actions is to lower its target interest rate by a full percentage point nearly to zero and provide guidance that rates would remain at this level until the economy is confident to weather the events. The Fed has not taken such drastic actions since the Great Financial Crisis. This monetary policy could boost the currency liquidity and support the flow of credit to households and businesses which aims to help the economy to recover. However, the downside is that the banking systems will have much lower profit due to the low interest rates. Although the Fed has reduced banks' reserve requirements to zero in order to encourage banks to extend loans, the requirements were already very low that this action will not be as useful as expected.
As a result, with the low interests, the money is so readily available and so cheap but because of COVID-19, this action could not draw people back to work and to shopping. Instead, financial institutes who make money from the interest rate on the loans and credit card debts, for example commercial banks, have to lower their expectations and their share price will accordingly be damaged. The Fed is doing its job to keep the financial system to meet the need of economy, but it will not take effect until the society get confident in addressing this global health problem. The low interest rates did not address the root cause of the problem but partly contributed to a financial sector crash instead.

Q4: Dilemma of Health Insurance Companies: Challenge vs. Opportunity

Undeniably, health insurance companies are facing a very hard time that no one even knows when it will end and whether it can be much harder.

The first challenge comes from unemployment, which leads to the risk of losing members in the future. According to Washington Post, more than 17 million Americans have filed for unemployment benefits in the past four weeks, a rapid and unprecedented deterioration in the U.S. economy that the nation has decided is necessary to combat the deadly coronavirus by keeping as many people as possible at home. Below display two charts that shows the savings rates of the U.S. and China. We see that people have much lower savings in the U.S., which makes U.S. households are much easier to suffer from financial difficulties hence cut down their budget for consumer discretionary. Therefore, it is predictable that insurance many lose their customer if the coronavirus keeps raging around the globe.

Figure 2 Saving Rate in China

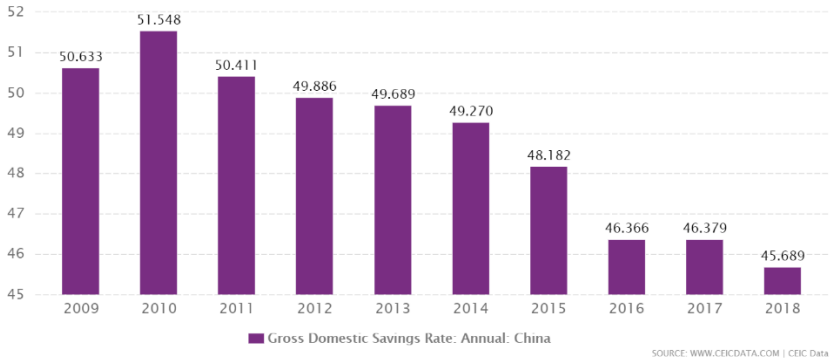
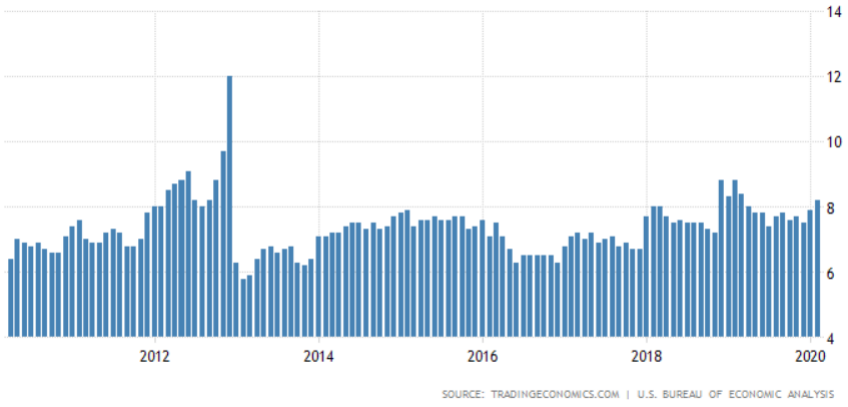


Figure 3 Savings Rate in the U.S.



Risks can also be seen in lower wage situation in the future. The United Nations' International Labor Organization (ILO) reported that the coronavirus is expected to decimate global working hours by nearly 7% in the coming months — a dramatic dip equivalent to 195 million full-time jobs worldwide. With roughly half of Americans getting their health insurance from their employer, these layoffs mean not only losing their income but also their medical coverage. During the last big recession, researchers at Cornell University found that 9.3 million Americans lost their health insurance between 2007 and 2009. As people lost work, their employer-provided insurance went away. During this time, roughly six in 10 Americans who lost their jobs became uninsured. Therefore, economy recovery may give hope to industries but households running out of savings, salary reducing, and layoffs can still become big problems in maintaining customers.

According to AHIP reporting health insurance providers respond to COVID-19, more and more healthcare insurance company decided to fully cover medically necessary diagnostic tests for COVID-19 or waive cost-sharing for COVID-19 testing performed at a hospital or approved laboratory. In March, representatives of major health insurance companies met with President Trump, where they voluntarily committed to covering COVID-19 testing without cost sharing such as copays and coinsurance. Although this saves more lives, it becomes a huge burden to

healthcare insurance companies. Analysts for California's insurance marketplace recently projected insurers nationwide could end up spending as much as $251 billion to cover care for coronavirus patients.

While the expenses of infectious diseases may be taken into consideration by insurance companies, hardly can such great global coronavirus pandemic be predicted. So, the combination of all the above does seem like a "perfect storm" that hurts the industry badly.

Q5: Cluster Analysis by Value Retention

Introduction

Though the pandemic fear triggered selling-off of almost all stocks in the first few weeks of the market crash, some industries were hit particularly hard while others stayed relatively strong against the downward trend. Moreover, after traders recovered from panic, they realized some industries might still stay steady during the entire pandemic period. As an analyst from J.P. Morgan noted in a recent article: "The other 78% of market cap [of S&P 500] comes from tech, financials, health care, utilities, communications, consumer staples and internet retailing, all of which should be less impacted by the downturn." [7] Stocks from these industries quickly bounced back from the recent bottom. Moreover, some companies, such as those from the pharmaceutical industry, benefited from the pandemic. Their stocks rose during the period we are investigating as a result.

On the last day of the dataset we are studying (Mar 23rd), the S&P 500 Index has decreased by one third from its recent highest point on Feb 14th. The market has since bounced back steadily.

Analysis Journey

In this part, we have done the clustering analysis according to the % value retention for 505 companies. Value retention is a simplified but effective measure that reflects the strength of a company to retain its value when the storm hits. The formula for calculating the % value retention is:

$$Value\ Retention = 100 + \left[\frac{Price\ at\ 3.23 - Initial\ Price\ at\ 2.14}{Initial\ Price\ at\ 2.14}\right] * 100$$

Step 1: Drop the NA row

When calculating the value retention, we fail to find out the prices for United Technologies. In that case, its value retention is NA and we drop the row for further analysis.

Step 2: k Means Clustering

We use the kmeans function to do the clustering and set the number of clusters as 3. After getting the result, we define the clusters as HVR, LVR and MVR according to the descending order of their cluster means. Finally, we create a table of cluster names and its size for further comparison.

[7] https://www.linkedin.com/pulse/why-stock-market-isnt-more-worried-david-kelly/?trackingId=

Step 3: k Median Clustering

We use the pam function in the package "cluster" to do the k median clustering and also set the number of clusters as 3. Similarly, we define the clusters as HVR, LVR and MVR according to the descending order of their cluster median value. Finally, we create a table of cluster names and its size for further analysis.

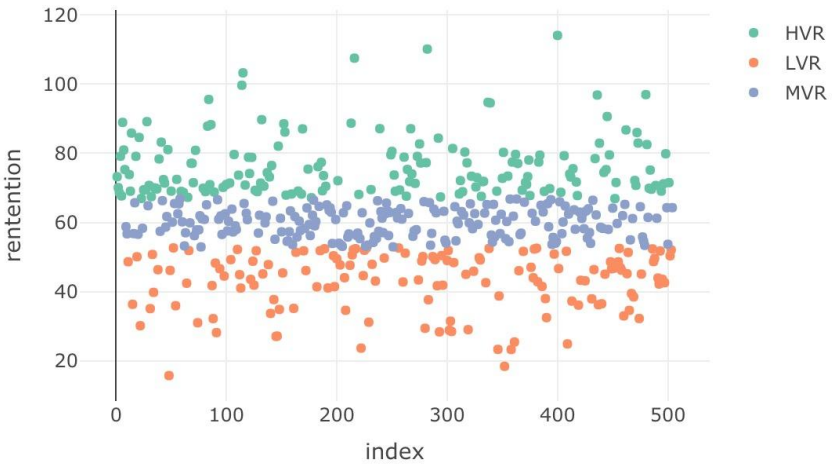
Step 4: Choose k Median Clustering as our final method

After comparing the sizes of the smallest group of k means and k median, we find out that the smallest group of k means has more members than that of k median. Therefore, we decide to use k median for the final algorithm since it avoids a cluster with fewer companies in it.

Step 5: Visualization

We use plotly in R to draw the clustering visualization. The x-axis is the unique index for each company, the y-axis the % value retention, the colors represent three types of clusters.

Figure 4 Cluster Visualization



Sector Analysis by Clusters

According to the table below, we could see that consumer discretionary, financials, healthcare, industrials, information technology are the top 5 sectors in terms of composite share in the S&P 500 Index. However, consequences brought by panic are significantly different to all kinds of industry when the US started reporting large coronavirus infection numbers.

	LVR	%	MVR	%	HVR	%	Sum
Communication Services	4	2.78	9	4.62	13	7.83	26
Consumer Discretionary	34	23.61	22	11.28	8	4.82	64
Consumer Staples	4	2.78	4	2.05	25	15.06	33
Energy	26	18.06	0	0.00	1	0.60	27
Financials	30	20.83	30	15.38	6	3.61	66
Health Care	5	3.47	18	9.23	37	22.29	60
Industrials	20	13.89	37	18.97	14	8.43	71
Information Technology	5	3.47	30	15.38	36	21.69	71
Materials	4	2.78	16	8.21	8	4.82	28
Real Estate	10	6.94	13	6.67	8	4.82	31
Utilities	2	1.39	16	8.21	10	6.02	28
Sum	144	100.00	195	100.00	166	100.00	505

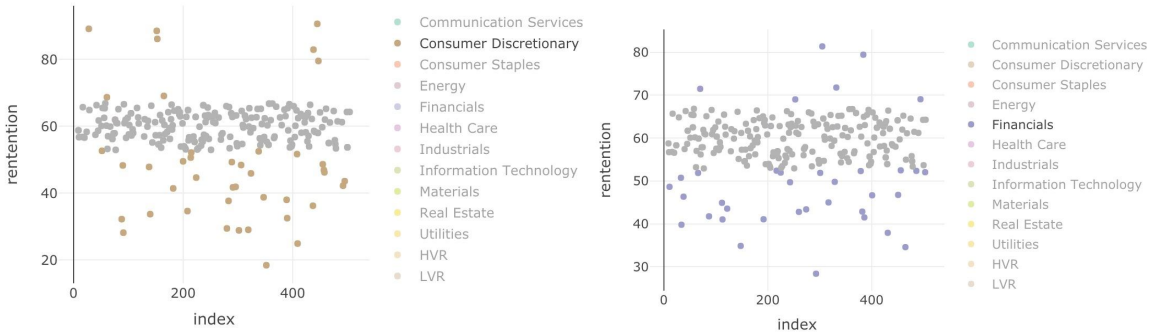
cluster	HVR	LVR	MVR	Sum
GICS.Sector				
Communication Services	50.00	15.38	34.62	100.00
Consumer Discretionary	12.50	53.12	34.38	100.00
Consumer Staples	75.76	12.12	12.12	100.00
Energy	3.70	96.30	0.00	100.00
Financials	9.09	45.45	45.45	100.00
Health Care	61.67	8.33	30.00	100.00
Industrials	19.72	28.17	52.11	100.00
Information Technology	50.70	7.04	42.25	100.00
Materials	28.57	14.29	57.14	100.00
Real Estate	25.81	32.26	41.94	100.00
Utilities	35.71	7.14	57.14	100.00

Table 2 Clustering in Sectors

Consumer Discretionary, Energy and Financials ranked top 3 in the Low Value Retention group, each sector accounting for approximately one fifth of the S&P 500 Index in terms of market cap. The Energy industry was hit especially hard in this period, while 96.3% of energetic companies had weak strength to retain its value and survive the storm. Energy industry suffered the greatest losses in this pandemic. The main reason for the crash of energy companies' stocks is well explained in another sector of the report. The pandemic disrupted the demand for crude oil. For example, China, in which more than a half of industrial products in the world are produced, was hit by the pandemic during the first two months of 2020. It suspended most of its business activities and the demand for crude oil experienced a sudden halt as a result, since China is one of the world's largest oil importing countries. On the other hand, crude oil prices crashed owing to the failure to reach an agreement between OECD and Russia on a production cut. Saudi Arabia, which led the OECD, announced later that it would recover to a historically high oil production and increase daily oil output to 11 million barrels. As a result, oil prices dropped below 20 USD a barrel. While most American drilling companies target shale oil and are heavy on debt, a price below 20 USD put their business at risk and caused a massive selling-off of their stocks.

At the time I am writing the report, OECD, Russia and the U.S. have reached an agreement on production cut and brought back the oil price to around 30 USD per barrel. However, a large number of American shale oil drilling companies are still in danger of insolvency and possible bankruptcies.[8] Consequently, their stock prices are nowhere near the February peak.

China, the country most heavily affected by the virus initially, is the main global production source of many clean energy technologies, such as solar panels, wind turbines. The disruption of Chinese economy causes potential supply chain bottlenecks for some technologies and components.



[8] https://www.reuters.com/article/us-global-oil-layoffs/oilfield-companies-cut-jobs-brace-for-bankruptcies-idUSKBN21P2S5

Exhibit 5a - Consumer Discretionary in LVR

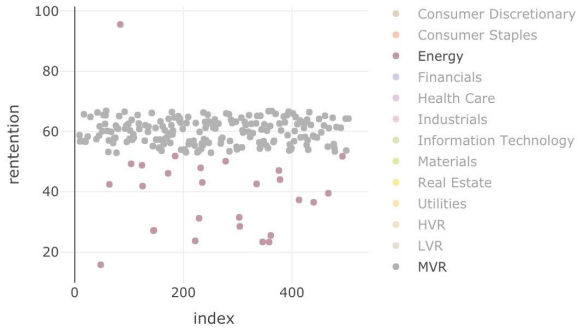


Exhibit 5b - Financials in LVR

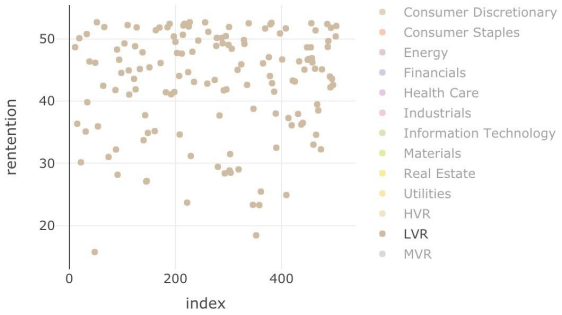


Exhibit 6a - Low Value Retention in LVR

Exhibit 6b - Low Value Retention

In the Middle Value Retention group, value retention ranged from 53% to 67%. Since the majority of the energy corporation Energy industry suffered heavy losses and clustered in the LVR group, it even disappeared in the MVR group. Information Technology, Industrial, Financials ranked top 3, accounted for 15.4%, 19%,15.4% respectively in MVR group.

Financial institutions have been under rigorous supervision since the financial crisis in 2008 and have been required to perform stress tests each year. Owing to their ability to keep a healthy balance sheet and strong liquidity, most financial institutions have been staying afloat (at least partially) during the market crash.

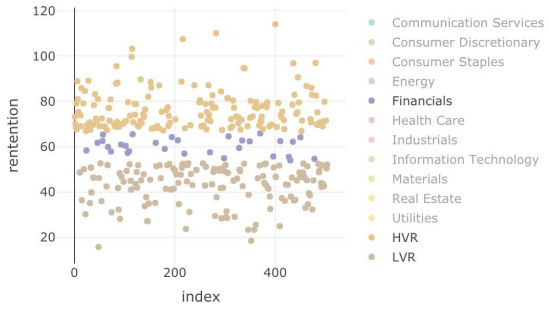


Exhibit 7a - Financials in MVR

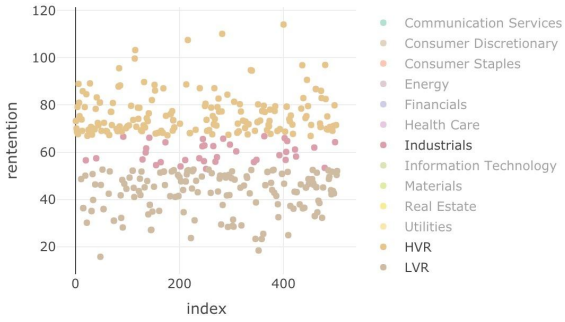


Exhibit 7b - Industrials in MVR

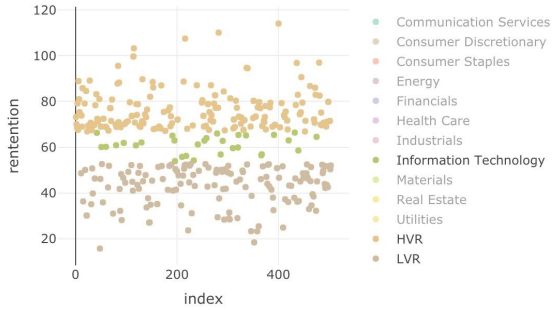


Exhibit 8a - Information Technology in MVR

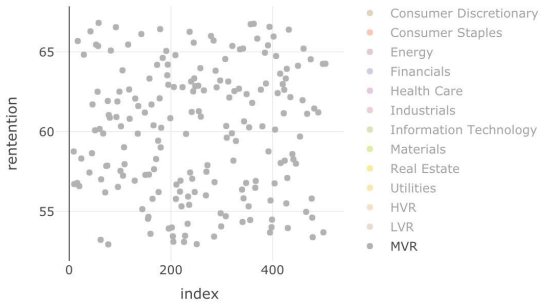


Exhibit 8b - Middle Value Retention

In the high value retention group, Information Technology did a decent job in staying strong against Covid-19, ranked second largest proportion. At the same time, the industrial and financial industry disappeared while the healthcare sector performed quite well in the HRV group, ranked first in the whole market. Besides, the consumer staples sector took up 15% of the HRV group, ranked third with 36 companies.

Most information technology companies have a lot of cash in hand and are light in assets compared to energy companies. A healthy financial status means IT companies can make it through the crisis facing a decline in revenue in the coming months. Moreover, businesses operated by IT companies are less impacted by the pandemic compared to those operated by retail stores. Some might benefit from the pandemic. As a large population are trapped on the sofa during the quarantine, they will turn on Netflix or HBO for entertainment. Subscriptions to streaming services indeed experience an explosive increase in March. Meanwhile, they rely on Zoom or other video conferencing platforms to work. All these companies fall into the category of Information Technology, and as they withstood the crash fairly well, the IT industry as a whole remained intact.

Meanwhile, it is no surprise that the consumer staples industry withstood the crash as well. People still frequented grocery stores for living necessities, e.g. toilet papers. Sometimes, people buy more than regular time. In the case of toilet paper, people pile up toilet papers in storage rooms for a stupid and nonsense fear of global toilet paper shortage.[9] Moreover, restaurants are closed in some states, and as a result, people are forced to cook at home. Those who never cook before now go to grocery stores for food. For example, I myself now spend more than usual time at Costco. As a result, consumer staples companies are expected to deliver better than average earning reports and investors tend to hold their stocks.

Last but not least, the healthcare industry stood strong against the market crash for obvious reasons. The rumors around the soon-available vaccine from a number of companies, such as Moderna, news surrounding curing effects of Remdesivir delivered by Gilead and fast test kits developed by Abbott make some biotech companies the very rare winners in the equity market crash.

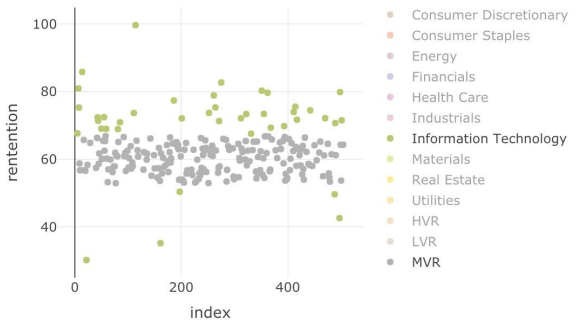


Exhibit 9a - Information technology in HVR

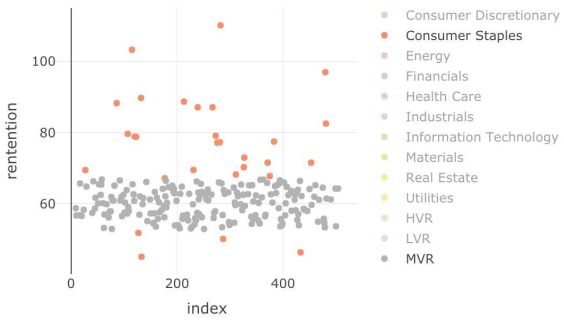


Exhibit 9b - Consumer Staples in HVR

[9] https://www.washingtonpost.com/national/coronavirus-toilet-paper-shortage-panic/2020/04/07/1fd30e92-75b5-11ea-87da-77a8136c1a6d_story.html

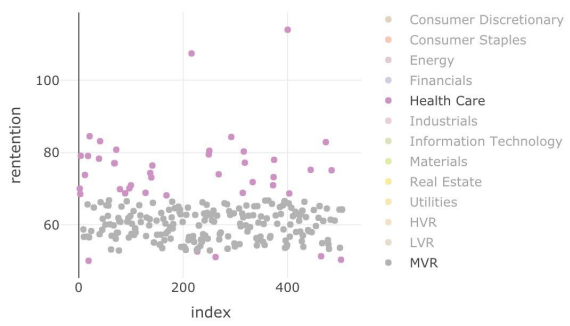


Exhibit 9c - Healthcare in HVR

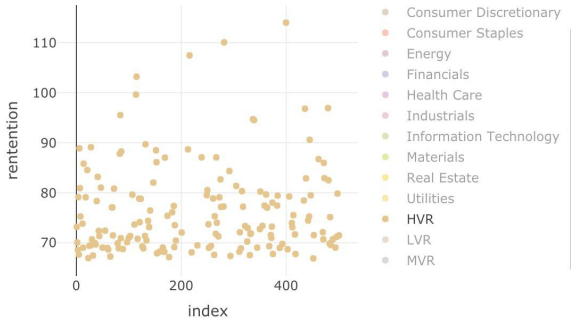


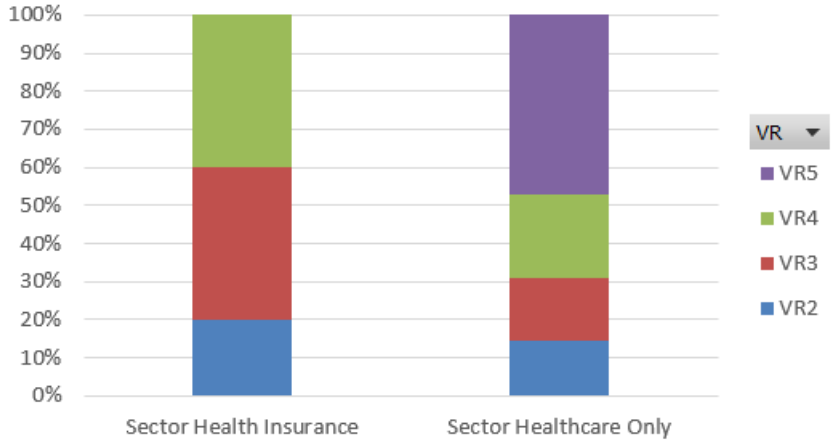
Exhibit 9d - High Value Retention

Energy companies were already struggling with dropping oil prices and uncertain market conditions before covid-19 began. With the virus spreading around the world, energy companies try to understand and contain its effects. It's no doubt that energy companies suffer greatest losses among industries. In contrast, Industrial and financials stand slightly strongly against the virus, since they are part of people's needs. On the contrary, healthcare and consumer staples did quite a good job during the pandemic period. Healthcare consists of medical supply companies and services that aim to improve the human body. With increasing numbers of confirmed cases, the demand for healthcare rapidly grows. Besides, Consumer staples companies provide all necessities of life. During the Self-quarantine period, people need to stay and eat at home. Therefore, the demand for consumer staples dramatically increases, which lead to strong retention ability of consumer staple companies.

Q6: Value Retention Distributions in Healthcare Sub-Industries

The chart below shows the VR distributions of Sector Health Insurance and Sector Healthcare Only. We see that Sector Healthcare Only has a better appearance in higher VR classes. Specifically, 70% of companies in Sector Healthcare Only are in VR5 and VR4 while only about 40% of companies in Sector Health Insurance are in VR4 and none in VR5.

Figure 5 Value Retention Distributions of Sub-Industry



This result is highly aligned with our conclusion in previous analysis of the dilemma of the health insurance companies. Capital market shows less confidence in those health insurance companies compared to companies in Sector Healthcare Only.

Q7: Government Rescue Package: Sector Healthcare Becomes A Darling!

In responding to Coronavirus pandemic, President Trump signed into law the Coronavirus Preparedness and Response Supplemental Appropriations Act of 2020. This $8.3 billion package provides funding for the country's response to coronavirus, including emergency telehealth waiver, vaccine development, and assistance for affected small business[10].

Later, the federal government also adopted Coronavirus Aid, Relief, and Economic Security Act (CARES Act), providing additional $2 trillion stimulus package to sector healthcare. In CARES Act, additional federal money is appropriated for special programs in the healthcare-related provisions. Notably, the bill extends funding for several healthcare programs, including Medicaid Disproportionate Share Hospital, National Health Service Corps, Community Health Centers, and Teaching Health Centers that operate Graduate Medical Education programs. CARES Act further expands Medicare telehealth flexibility, including for federally qualified health centers, rural health clinic and home dialysis patients. The bill temporarily lifts the Medicare sequester and institutes an add-on payment for hospital in-patients with COVID-19[11].

Highlights of these two Acts include:

(1) Hospital systems

In CARES Act, it provides new $100 billion for hospitals and healthcare providers in responding to concerns from the healthcare community over the intense impact of covid-19 response. It also provides $250 million for hospital preparedness program grants or cooperative agreements with current grantees, subgrantees or other entities meeting criteria. Section 3708 provides prompt economic assistance to healthcare providers on the front lines fighting the covid-19 virus, helping them to furnish needed care to affected patients. The payments for hospital, physician, nursing home, home health and other care is boosted. Section 3710 increases the payment that would otherwise be made to a hospital for treating a patient admitted with COVID-19 by 20 percent. Section 3719 accelerates payment program during the COVID-19 emergent period.

(2) Safety device manufacturers and PPE

[10] https://www.asco.org/practice-policy/policy-issues-statements/asco-in-action/congress-passes-funding-bill-respond

[11] https://www.hklaw.com/en/insights/publications/2020/03/coronavirus-response-cares-act-summary

In Coronavirus Emergency Appropriations Act, pharmaceuticals and medical supplies such as masks and personal protective equipment are provided to support healthcare preparedness and Community Health Centers to improve medical surge capacity, taking up $1 billion.

(3) Telemedicine

In Coronavirus Emergency Appropriations Act, $500 million is estimated to be spent in telehealth which allows Medicare beneficiaries to receive telehealth services from home, without the potential risk of exposure associated with visits to medical care facilities. Telehealth services can be provided to Medicare beneficiaries via phone if the phone allows for audio-video interaction between the provider and the beneficiary. Patients in rural areas or have chronic diseases such as dialysis can get more care in the safety of their home.

In CARES Act, Section 3212 declares that telehealth network and telehealth resource center grant program will expand funding for evidence-based telehealth networks and telehealth technologies by $29 million for each fiscal year from 2021 through 2025.

(4) Veterans' healthcare[12]

The Department of Veterans Affairs (VA) will receive $19.6 billion in additional funding to fight the pandemic. The majority of the money allocated to VA will go directly to the Veterans Health Administration. This funding will provide essential medical services, including vital medical and protective equipment, testing kits, personal protective equipment (PPE), and medical supplies to support growing demand for health-care services at VA facilities and through telehealth services. Provisions in the bill require VA to provide PPE to all home health-care workers serving veterans at home and in the community. To support VA staff working overtime during the COVID-19 pandemic, the CARES Act waives pay caps for VA staff so they can be fully compensated for hours served.

The funding provided by the CARES Act will ensure VA is able to provide additional care and support for the most vulnerable veterans. The most notable change in how veterans are able to receive VA health care during the pandemic is the expansion of telehealth services. Funds to bolster telehealth capabilities through increased telework and call center capabilities will deliver health care and mental health services while helping mitigate the risk of virus transmission.

(5) Extra financial support for CDC and NIH

Coronavirus Emergency Appropriations Act funds $2.2 billion for the CDC to support federal, state, and local public health agencies to prevent, prepare for, and respond to the coronavirus, and $475 million of it must be allocated within 30 days. As for vaccines, therapeutics, and diagnostics, NIH are funded $826 million for basic research and development.

In CARES Act, $4.5 billion is available for CDC from Fiscal Year 2020-2022 for public health preparedness and response. And $945 million for NIH to support the expansion of research plans under the first supplemental.

(6) R&D joint ventures with pharma

[12] https://www.legion.org/veteranshealthcare/248698/covid-19-stimulus-bill-provides-nearly-20b-va

CARES Act provides $3.5 billion for the Biomedical Advance Research and Development Agency to support the development of countermeasures, vaccines and other technologies, treatments and therapies.

(7) Other biotech involved in vaccine and drug development

Biotech companies also get funding from government for COVID-19 treatments development.

BARDA will provide Mesa Biotech, Inc. of San Diego, California, with technical expertise and $561,330 in immediate funding to pursue eventual Food and Drug Administration (FDA) approval or clearance of its diagnostic test. With BARDA's support, the company can complete the development work necessary to request Emergency Use Authorization (EUA) from the FDA for the Accula COVID-19 point-of-care test within two months of the award. The Accula COVID-19 diagnostic test requires minimal sample handling, and a 30-minute sample-to-result time[13].

Besides, Emergent BioSolutions has received $14.5 million in funding from the Biomedical Advance Research and Development Agency to speed the development of expedite COVID-19 plasma therapy[14].

(8) Small business

Apart from funding the healthcare-related provisions, $ 1 billion in loan subsidies are available to help small business, small agricultural cooperatives, small aquaculture producers, and nonprofit organizations which have been impacted by financial losses as a result of the coronavirus outbreak. This funding could enable the Small Business Administration to provide an estimated $7 billion in loans to these entities[15].

We suppose that sector healthcare is comparatively robust under serious economic circumstance because of the government rescue packages and supports. This information inspires us that healthcare can be a protected sector.

Especially, we find telehealth as a promising sector within the Sector Healthcare. With more and more attention and funding, telehealth will develop rapidly. Also, under the circumstance of covid-19, people will quickly adapt to online medicine and feel comfortable to use it, which will be an opportunity for the development of telehealth. We, as students with data analysis backgrounds, can help telehealth companies to analyze their huge amount of patient data and provide advanced online medical services with AI techniques. Actually, we have seen may job opportunities in this area these days. Despite the current downturn in the labor market, we find that there are still many emerging opportunities in healthcare analysis, giving us confidence that the sector we are experts in would not be as severely impacted by current crisis.

Q8: Social Implications of An Uneven Market Crash

[13] https://www.hhs.gov/about/news/2020/03/18/hhs-supports-mesa-biotech-develop-rapid-diagnostic-detect-novel-coronavirus-infections.html

[14] https://techcrunch.com/2020/04/03/emergent-biosolutions-gets-14-5m-in-federal-funding-to-expedite-covid-19-plasma-therapy-development/

[15] https://www.asco.org/practice-policy/policy-issues-statements/asco-in-action/congress-passes-funding-bill-respond

We rank the weighted average of Value Retention of different sectors, and their performance are shown as below.

GICS.Sector	Weighted_VR (%)
Consumer Staples	76.50
Health Care	72.11
Communication Services	70.97
Information Technology	69.34
Consumer Discretionary	68.83
Utilities	63.93
Materials	63.25
Real Estate	60.95
Industrials	57.78
Financials	57.15
Energy	44.29

Table 3 Weighted average of Value Retention of different sectors

It can be seen that sectors like Health Care, Communication Services, and Information Technology are relatively better protected under covid-19 with less decrease in value. We regard sectors in this condition as chance of survival group. By contraries, sectors like Industrials and Energy are relatively less immune to sudden crashes due to covid-19 with dramatic decrease in value. We regard sectors in this condition as risk of collapse group.

We find that there are significant differences in education status between these two groups. According to U.S. Bureau of Labor Statistics, among the employed, the likelihood of working in a management, professional, or related occupation increases with educational attainment. By contrast, the likelihood of working in service occupations; natural resources, construction, and maintenance occupations; and production, transportation, and material moving occupations decreases by educational attainment.

In 2016, the majority of employed people with at least a bachelor's degree worked in management, professional, and related occupations. Sixty-three percent of people with a bachelor's degree, 85%with a master's degree, 91% with a professional degree, and 94% with a doctoral degree worked in this occupational group.

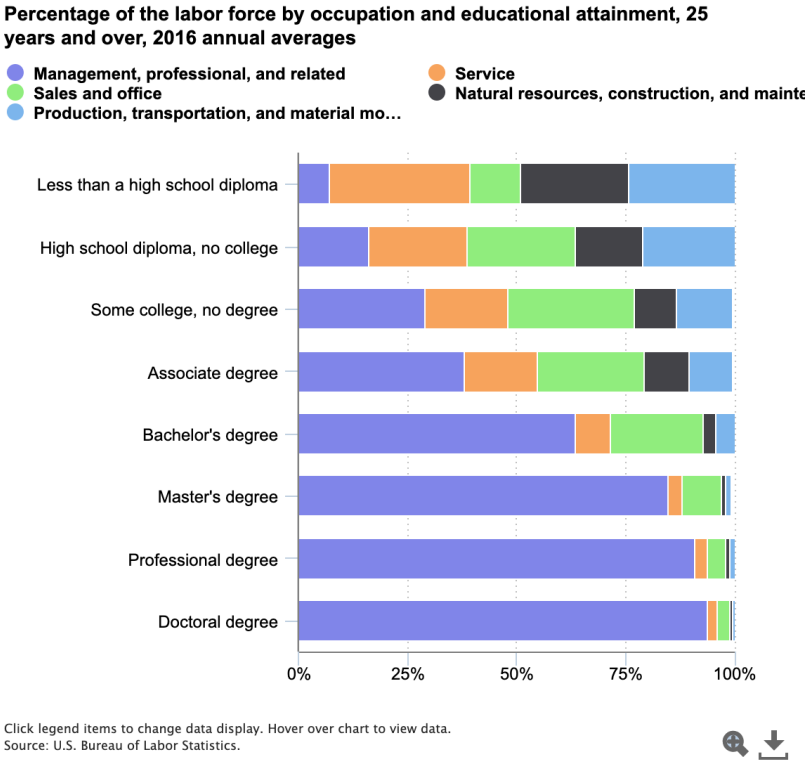
Workers with less than a high school diploma had the highest likelihood of being employed in service (32%); natural resources, construction, and maintenance (25%); and in production, transportation, and material moving (25 %) occupations. Less than 1 in 10 were employed in management, professional, and related occupations.

Workers most likely to be in sales and office occupations were those who had at least a high school diploma but did not have an advanced degree.

In other words, the sectors of chance of survival group such as Health Care, Communication Services, and Information Technology are mostly the social clubs of employment of highly educated and elite workforce, while blue-collar contrast mostly in the groups with sectors already at the risk of collapse.

To conclude, the market may encounter even more of inequality of job opportunity hence income and wealth after corona virus. People with low education level will face with high risk of losing job and worse health condition due to payment failure.

Figure 6 Occupations vary by education



Summary

In this assignment, we witnessed the stock market crash under the attack of coronavirus. There are some sectors such as the financial and energy sector that are going through a really bad time with the relatively low value retention. As the virus is pushing many companies to the edge of bankruptcies, it also brings opportunities to some sectors such as healthcare, especially the telehealth industry.

As large changes are happening in different sectors, the job market is also impacted to a great extent. The sectors of chance of survival group such as Health Care, Communication Services, and Information Technology are mostly the social clubs of employment of highly educated and elite workforce, while blue-collar contrast mostly in the groups with sectors already at the risk of collapse. The market may encounter even more inequality of job opportunity hence income and wealth. People with low education level will face with high risk of losing job and worse health condition due to payment failure.

Appendix

1. S&P 500 Data with Value Retention

(Also see in the sp500-data(with rv).csv)

2. R code in Cluster Analysis

```
#rm(list = ls())
#gc()
set.seed(123456)
install.packages("openxlsx")
install.packages("cluster")
library(openxlsx)
library(stats)
library(dplyr)
library(cluster)
library(ggplot2)
library(hablar)
library(shiny)
library(plotly)
#sp500_companies = read.xlsx('./hello.xlsx')
#summary(sp500_companies)
#sp500_companies[is.na(sp500_companies$rentention) == TRUE,]
#sp500 <- sp500_companies %>%
#    select(Symbol, -Security,GICS.Sector, GICS.Sub.Industry, MC2.14,MC3.23, SP2.14, SP3.23)
#summary(sp500)

sp500 = read.csv('./sp500-data(with rv).csv')
# k means clustering
fit_kmeans <- kmeans(sp500$value_retention, 3) # k means clustering
fit_kmeans
fit_kmeans$centers # find out the centers of three clusters
result_kmeans = as.data.frame(fit_kmeans$cluster)
tb_result_kmeans = table(result_kmeans)
names(tb_result_kmeans) = c("HVR","LVR", "MVR") # define the groups as high, low, medium
tb_result_kmeans
sp500_kmeans = cbind(sp500, fit_kmeans$cluster)

#names(p8_0)[names(p8_0) == "Area"] <- "area"
names(sp500_kmeans)[names(sp500_kmeans)=='fit_kmeans$cluster'] <- 'cluster'

sp500_kmeans<-sp500_kmeans %>%
   convert(fct(cluster))
sp500_kmeans <- within(sp500_kmeans, cluster[cluster == 1] <- 'LVR')
sp500_kmeans <- within(sp500_kmeans, cluster[cluster == 2] <- 'HVR')
sp500_kmeans <- within(sp500_kmeans, cluster[cluster == 3] <- 'MVR')

# k median clustering
fit_kmedians = pam(sp500$value_retention,3) # k median clustering
results_kmedians = as.data.frame(fit_kmedians$clustering)
tb_result_kmedians = table(results_kmedians)
fit_kmedians$medoids    # find out the medoids of three clusters
names(tb_result_kmedians) = c("HVR","MVR","LVR") # define the groups as high, medium, low
tb_result_kmedians
sp500_kmedians = cbind(sp500, fit_kmedians$clustering)

names(sp500_kmedians)[names(sp500_kmedians)=='fit_kmedians$clustering'] <- 'cluster'

sp500_kmedians<-sp500_kmedians %>%
   convert(fct(cluster))
sp500_kmedians<-sp500_kmedians %>%
   convert(fct(GICS.Sector))

sp500_kmedians <- within(sp500_kmedians, cluster[cluster == 1] <- 'HVR')
sp500_kmedians <- within(sp500_kmedians, cluster[cluster == 2] <- 'MVR')
sp500_kmedians <- within(sp500_kmedians, cluster[cluster == 3] <- 'LVR')

# Since the smallest group of kmeans is 109 and that of kmedians is 103, we use kmeans in this case.
#         kmedians_company_group$category         =         as.factor(case_when(kmedians_company_group$`fit_kmedians$cluster`         ==         1~"HVR",
kmedians_company_group$`fit_kmedians$cluster` == 2~"MVR", kmedians_company_group$`fit_kmedians$cluster` == 3~"LVR"))
sp500_kmedians$index = 1:nrow(sp500_kmedians)
```

```
p1 <- ggplot(sp500_kmedians, aes(x=index, y=value_retention))
p1+geom_point(aes(colour = factor(GICS.Sector), shape = factor(cluster)))

ct1<- crosstab(sp500_kmedians, row.vars = 'GICS.Sector', col.vars = "cluster", type = "f")
write.csv(ct1$table,"ct1.csv")

ct2<- crosstab(sp500_kmedians, row.vars = 'GICS.Sector', col.vars = "cluster", type = "r")
write.csv(ct2$table,"ct2.csv")
```