

Agricultural Sector Price Inflation in Covid-19 Recovery Stage: An Empirical Investigation

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Abstract: Since the middle of 2021 most of world in recovery phase as long as economic activity is concerned. Because that is the when majority of the population in developed world has already been vaccinated and decisions were made if booster shots would be needed who are already vaccinated to keep the required immunity. In this research US economy is selected to see how agricultural prices are changing. What are different variables which are impacting the prices during this time period? Time period selected for this study is June 01, 2021 to Jan 31st, 2022. We picked daily data to do this analysis for USA markets Bloomberg Agricultural index is taken to see the impact on the performance of agricultural sector. Independent variables selected are some supply side and other is the proxy which can have impact on demand. This variable is Infectious disease tracker from Federal Reserve Economic Data (FRED) site, this tracks volatility based on the infectious disease. This variable Infectious Disease Equity Market Volatility Index (IDEMV). Other variables are also from the market site which are also related with transport whether it is Land or Sea. SPY index and 10 year treasury are the two broader market indices which can address the economy for this time. Supply side variables are like Dow Jones transportation index, and US marine Transportation Index. US commodity Index can also be considered to see demand side impact as broader commodity market. Auto Regressive Distributed Lags (ARDL) technique was used to study this analysis, this also shows relationship for both short and long run relationship among variables. Different tests were run for pre and post analysis of the data and results. Tests run for this are Adjusted Dicky fuller test for unit roots (ADF), Variance Inflation Factor (VIF) for multi-collinearity, heteroscedasticity, cointegration and finally Cumulative Sum (CUSUM) test for data breakdown analysis. Other than supply and infectious disease impact on the Agriculture index, impact of commodity index and broader market was also tested. This study found out that in the long run no variables are statistically significant but in the short run analysis strange thing is that infectious disease analysis is not statistically significant for this time frame, similarly transportation indices are not statistically significant but only broader market variables are significant which shows that investors now have realized that things are becoming normal and even agriculture index is behaving according to broader markets.

Keywords: Agriculture Index, Infectious Disease Equity Market Volatility Index (IDEMV), Federal Reserve Economic Data (FRED) and US Marine Index

Introduction

Historically whenever there is some slowdown in economy there has been some stimulus both fiscal and especially from central banks. This slowdown or recession could be for different reasons, in 2001 it was due to 9/11 and in 2009 it was Global Financial Crises. In 2019 and especially at the start of 2020 world economy was struck with Covid-19 situation and the world economy was in tail spin. Due to this reason all countries and especially developed countries tried their best to keep world economy afloat at some reasonable level. To do that all developed nations fulfilled their duty to have both fiscal and monetary stimulus. Stages like this approach have been to overshoot with stimulus like in 2009 and not under shoot and adjust stimuli later. With all this effort economy at least started coming back with cautious approach. Cautious behavior can be seen in Infectious Disease Equity Market Volatility Index (IDEMV) from FRED site which shows daily behavioral response due to daily volatility based on new cases Covid-19 and deaths. When we ran regression with this data until the middle of 2021 we saw that IDEMV was statistically significant till that time with the Agricultural index. Since middle of 2021 even with the eruption of new variants the economy looks like stabilizing and overall inflation especially in agriculture is coming back based on CPI numbers (Khan et al, 2020).

It is noteworthy that even with large stimulus since 2009 we have seen rocky economy all over the world not coming to the level based on GDP growth to the same level seen before the Global Financial Crises. It has been seen that world economy is very much dependent on the stimulus still in place since 2009. Whenever Federal Reserve tried to slow down different stimuli we see hiccups in economic activities. Federal Reserve was trying to raise rates before Covid-19 incident to some normal level but due to Covid-19 Federal Reserve had to pull those rates back to zero with additional stimuli of different kinds (Zamir et al, 2017).

It can be seen based on the economic ups and downs that it can change the investor's perspective towards investing as it is explained in different studies like Zheng (2014), Andrei and Hasler (2015) and Godil et al., (2020). According to Nishiura et al., (2020) Covid-19 shock to the economy is such that it has costed the total world at least world income loss of in range of \$60 Billion. It is also seen that stock markets in the whole world plunged and especially the bigger markets like US equity market dropped by at least by 35% by market capitalization, Barro et al., (2020) when US was accounted for about 33% of all world Covid-19 cases (Algahtani et al., 2020).

Because of this income loss which is not only in the USA but also all over the world to cover the impact of these losses only USA implemented at least of \$4 Trillion stimulus in different forms. Similar steps were taken by different countries but especially the developed nations based on the resources each country had available. Based on these economic implementations equity markets and economies started coming back even though cautiously based on the daily pandemic situation.

Infectious Disease Equity Market Volatility Index can also be related to the Efficient Market Hypothesis (EMH), because it is known based this hypothesis that in the short run markets can be dictated by the news which can be good or bad till the point that market settles down till the impact due to news fades. In his study Li (2018) found out that news depending on which way impacts the demand and ultimately consumption which could have impact on the portfolio decisions. Based on the news activity Indices can be created like the Infectious Disease Equity Market Volatility Index. Baker et al., (2020) created this type of index which covers news related to Pandemics like Covid-19, and similarly others like H5N1, Ebola, MERS and SARS. This index shows market volatility based on the Disease index.

In the beginning of Covid-19 all the economic activity was halted due to restrictions by all the global governments because no country had clear understanding how to properly respond to this pandemic. After all the stimulus was in place when governments started opening the economic activities and vaccinations were started at the end of 2020. Confidence in the world population started coming back and similarly demand for different commodities and industrial items started coming back. On the other hand supply was little restricted due to shutdowns and illnesses. Main hit was to the Agricultural supply and demand difference, due to that prices and especially agricultural prices started going up when personal consumption came back and restaurants and entertainment industry started coming back. In this study Bloomberg Agricultural Index (BAI) was picked as proxy for Agricultural demand and pricing. Other than BAI and IDEMV other variables related to the commodities and broader markets were picked to analyze the impact of these variables on the agricultural pricing.

Literature Review

It is known that according to Efficient Market Hypothesis (EMH) markets can move according to the news at least for short term till impact the news fades in the pricing of the market. This impact basically is according to behavior of the investors because news changes the sentiment of the investor and it translates into the pricing behavior of the market. Neiderhoffer (1971) in his research found out that market performance depends significantly on the news because it changes investor's behavior. Black (1976) has also mentioned in his research that stock market prices change inversely with the volatility in the markets. Volatility and news they play into each other. According to Badeeb & Lean (2018, Zhu et al., (2019), Hung (2019) and also Smales (2017) have done research on this topic and they have found out that with negative news volatility increases in the markets because this plays into the sentiment of the investors.

There are other studies which have covered the topic of news on the performance of the stock markets and the volatilities. Li (2018) found out that government media or news can even have higher implications for the stock market compared to other media. Su et al., also found out that there could be volatility based on the news regarding the financial uncertainty. Similarly according to Zheng (2014) research there is statistically significant and negative relationship between investor's sentiment and the market performance. Since the eruption of Covid-19 Pandemic there are some studies which show relationship of commodities in relation with this pandemic. Wang et al. (2020) studied crude oil and agricultural commodities and found out the correlation between them. Similarly Poudel et al. (2020) found out that there significant impact on the agricultural commodities due to the pandemic situation. Even though Elleby et al. (2020) found out that food consumption in developing countries did not fall during the pandemic but these countries have some other insecurities. This can be explained because in developing countries food consumption is mostly at lower level than developed countries basically that is close to their basic necessity how it can fall further. There is one more study which mentions that Brazil being a major agricultural exporter could have positive impact going forward (Seleiman et al. 2020).

Pandemics like Covid-19 can have influence on the behavior of investors which can translate into fear and ultimately can change the market sentiment. Barro et al. (2020) in their study analyzed the psychological effect of Covid-19 pandemic. They found that investors during the pandemic times behave differently. In the beginning of pandemic we saw crude market crash due to demand destruction concerns but Gharib et al. (2020) in their study found that there is no correlation between crude and equity markets. On the other hand Al-Awadhi et al. (2020) found out based on China market that Covid-19 created massive volatility.

Fetzet et al. (2020) studied Infectious Disease Equity Market Volatility Index impact on electricity volatility and found out that there is huge volatility due to infectious disease concerns. Regarding news Nikkinene & Peltomaki (2020) found out that web search is directly linked with the volatility of the markets.

There have been discussion about the supply and demand recently even though in this study it has tried to pick variables which can have impact on both supply and demand but main focus is what is the relationship of Infectious Disease Equity Market Volatility Index on the agricultural index. That is why for this study market based indexes for agriculture Bloomberg Agriculture Index (BAI), overall market index SPY as the proxy, commodity index trucking index and marine index are picked for this analysis. These trucking and marine indices cover basically supply side activities.

Data and Methodology

This study examines the impact of fear index like Equity Market Volatility Index (IDEMV), health related news index, S&P 500 Index (SPY), 10yr Yield (YDC), both variables show broader market and economic activity Dow Jones Trucking (DJUSTK), Dow Marine Index (DJUSMT), both of these variables cover supply side of the economy and US commodity (USCI) indices and this index covers broader view of the commodity activity side on the Bloomberg Agriculture Index (BAI). Both Fear index and the Commodity index are selected to address the demand side of the economy. This way we are able to see the relationship on the Agriculture Index, with other independent variables.

$$BAI = f(SPY, Yield, DJTR, DJMT, USCI, IDEMV)$$

Daily data was picked for this analysis, range was picked from the June of 2021 till the end of January, 2022. This range was picked based on the effectiveness of the vaccinations the rates of infections started going down even with small eruption of omicron and other variants overall infections are towards lower side which results in the confidence building of the larger populations. After picking this data based on Augmented Dick Fuller's (ADF) analysis some of these variables are stationary at level $I(0)$ and some of them are stationary at first difference $I(1)$. Based on that finding Autoregressive Distributed Lag technique was picked to do analysis of these variables.

For complete analysis based on Bayesian Schwarz Information Criterion (BSIC) technique maximum lags were picked which was one. Different techniques for pre and post analysis were also used like Variance Inflation Factor (VIF) for multicollinearity, heteroscedasticity was also tested for this. Similarly Pesaran/Shin/Smith ARDL Bound test, Shin et al. (2014), was run to check the cointegration and finally CUSUM and CUSUM Squared was run to test the boundedness of the model.

Results and Discussions

After collecting the data stationarity test was done for all variables with Augmented Dick Fuller (ADF) test. Then Schwarz Bayesian Information (SBIC) test was used to check the lags used for this modeling and testing and selection was of lag 1. Then Error Correction ARDL model was tested with maximum lags of 1 for all variables. Error Correction model was also restored to run the regression for these variables and to run VIF test based on this regression. Other tests which were used are Breusch-Pagan, Durban Watson, Pesaran/Shin/Smith ARDL Bound test, and CUSUM & CUSUM Squared tests. All these results were analyzed based on the 5% significance criteria.

For multicollinearity we can test this with correlation coefficients or on the base of Variance Inflation Factor test. These tests are shown in Table 1 & 2 and both of these results show that there no problem of Multicollinearity.

Table 1. Correlation coefficients for different variables

<i>Variables</i>	<i>BAI</i>	<i>SPY</i>	<i>YDC</i>	<i>IDM</i>	<i>DITK</i>	<i>USCI</i>	<i>DIMT</i>
BAI	1.000						
SPYR	-0.083	1.000					
YDC	0.135	-0.152	1.000				
IDMT	-0.068	-0.072	0.079	1.000			
DITKR	-0.042	0.666	-0.080	-0.061	1.000		
USCIR	0.141	0.457	-0.040	0.031	0.306	1.000	
DIMTR	0.154	0.420	-0.135	-0.087	0.301	0.482	1.000

The results in Table 1 show correlation among all dependent and independent variables and we did not see any issue with the data. Table shows VIF results for different variables.

Table 2. Variation Inflation factors for different variables

<i>Variables</i>	<i>VIF</i>	<i>1/VIF</i>
SPYR		
L1	4.34	0.231
D1	4.34	0.231
DJTKR		
L1	4.19	0.239
D1	4.03	0.248
USCIR		
L1	3.06	0.327
D1	2.69	0.372
IDMVT		
L1	2.65	0.377
D1	2.62	0.381
DJMTR		
L1	2.45	0.408
D1	2.35	0.426
YCHANGE		
D1	1.95	0.514
L1	1.90	0.526
BAI		
L1	1.23	0.810
Mean VIF	2.91	

To test long-run relationship Pesaran/Shin/Smith ARDL Bound test was run, Table 3 shows these results. Based on F statistics it shows that there is a long run relationship.

Table 3. ARDL Bound Test

<i>Model</i>	<i>F-statistics</i>	<i>Max Lags</i>	<i>Level of Significance</i>	<i>Bound test critical values</i>	
Dep/Ind Variables	8.000	1	1%	I(0) 3.15	I(1) 4.43
			5%	2.45	3.61
			10%	2.12	3.22

When we run ARDL error correction model it shows us results for both long and short run models. Table 4 and 5 show results for both of these models. Based on these results from ARDL ECM model run that in the long run we do not see statistically significant variables. When we check the short run model that shows that both SPY the broader market index and the USCI the commodity index both show statistically significant for Agricultural Index (BAI). We also collected and ran same model for the data before June 2020 when we compare results from both datasets it is noted that for data set before June 2020 IDMVT shows statistical significance but for data beyond June 2020 which is related to this research it does not show that statistical significance.

Table 4. Short Run Coefficients for ARDL ECM model

<i>Variables</i>	<i>Coefficients</i>	<i>Std Error</i>	<i>t-Statistics</i>	<i>Probability</i>
D(SPYR)	-0.1683084	0.0850496	-1.98	0.050
D(YCHANGE)	0.0027217	0.0149097	0.18	0.855
D(IDMVT)	-0.0014580	0.0099803	0.15	0.884
D(DJTKR)	0.0553671	0.0472207	1.17	0.243
D(USCIR)	0.9517180	0.0527977	9.38	0.000
D(DJMTR)	0.0318803	0.0279363	1.14	0.286
Coint-Eq/ECM(-1)	-.010788700			
R-Squared	0.51201648		Adj R-Squared	0.45825558

From the results it is clear that even though change in SPY the broader market is statistical significant but relationship is inverse. On the other hand that change commodity index USCI is statistical significant but this has direct relationship. This contrary relationship can be explained with the investor’s attitude based on this pandemic outcome.

ECM(-1) coefficient shows adjustment to the long run relationship in the short run. Basically how quickly the long run relationship can be adjusted in one period or in the short run. Based on the coefficient information it is noted that this adjustment is little on slower side. For adjustment to take place first of all this coefficient should be negative which the case is for this analysis. Slowness of this adjustment can be explained because things are still in flux stage and investors are waiting for things to finally settle down. R-Squared and Adj R-Squared also show that model significance is reasonable.

Table 5. Long Term Coefficients for ARDL ECM model

<i>Variables</i>	<i>Coefficients</i>	<i>Std Error</i>	<i>t-Statistics</i>	<i>Probability</i>
L(SPYR)	-23.69296	47.28604	-0.050	0.617
L(YCHANCGE)	-2.690074	5.771481	-0.470	0.642
L(IDMVT)	-0.116112	1.075978	-0.110	0.914
L(DJTKR)	6.869139	16.19719	0.420	0.672
L(USCIR)	46.77593	91.97306	0.510	0.612
L(DJMTR)	-0.426836	3.723490	-0.110	0.909

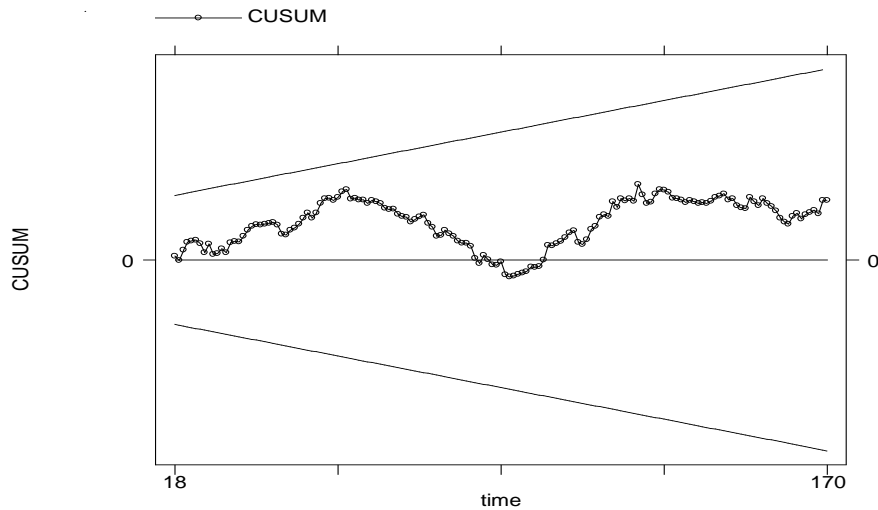


Fig1. Cumulative of Sums plot for the model to test boundedness of Model

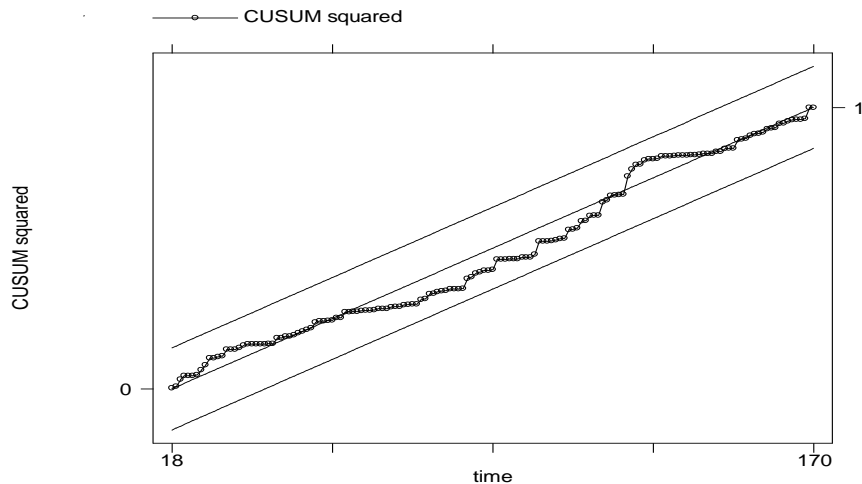


Fig2. Cumulative of Sums squares plot for the model to test boundedness of Model

Finally we can also see based on CUSUM and CUSUMSQ (Fig1 & 2), plots that this model does not have any issue with structural breakdown and this done for 5% significance.

Conclusions

This study is done to see the relationship of the broader markets variable, commodity index, Equity Market Volatility Index and also if there some relation towards transport indices whether it is land or sea with the agricultural index. This is done with selection of daily data from June 2021 to January 2022 which is current data. This time duration was picked because most of the population has gone through the vaccinations and things from pessimistic behavior are turning towards optimistic. On one side based on selected variables we saw that there is no long run statistical significant relationship. This make sense because there should be long run relationship because things are in flux stage at this time. On the short run analysis change is SPY index is statistical significant but it show negative relationship but with commodity index it is showing positive statistical significance. When we see broader market relationship that can be explained according to investor behavior. When we have issue with surge in new cases and deaths or negative news for the pandemic cases, on one side investors think that all the commodities demand going forward will be lower which also includes agricultural, and off course it can be said in opposite direction for relationship. But contrary to that because things are not going to be that rosy that means stimulus which is in place can be extended for longer time period which is considered good for broader market. This is the reason that broader market (SPY) and commodities show opposite direction relationship towards Agricultural index. No significant relationship was observed with the transport indices like trucking and marine. For policy implications this research could be helpful this shows that investors are now feeling confident about the economy and monetary and fiscal policies which can be tweaked according to the situation going forward.

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