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The dimensions and patterns of Sino-US trade

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Abstract
The paper endeavours to explore the trends ,cycles and seasonal variations of Chinese export to USA and import from USA using Hamilton (2018) regression filter model during 1990-2019.The Johansen cointegration and vector error correction among Chinese export to USA with GDP of China and USA,nominal and real effective exchange rates of China,FDI inflows and openness of China and total liquidity of USA were examined.Similarly,cointegration and vector error correction among Chinese import from USA with GDP of China and USA, nominal and real effective exchange rates of China, openness and total liquidity of China and FDI inflows of USA were calculated in which in both the cases VECMs are unstable and non-stationary. In the former case, there are six cointegrating equations and in the latter case, there are at least four cointegrating equations. Long run causalities from real effective exchange rate and openness of China to Chinese export to USA and import from USA were visible.

Key words: *China's trade with US,decomposition,cointegration,vector error correction*
JEL Classification Codes:C22,C32,F12,F14, F17,F41

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I. Introduction

China has emerged as the world's leading dominant country because its world GDP share is now 18.69% in comparison to 15.2% of USA.The Chinese export and import shares of the world reached at 13.23% and 10.79% respectively in 2019 as against 8.71% and 13.35% of USA.China's total liquidity share turned to 25.64% of the world in 2019 which is the highest in the world.Chinese currency Yuan has included in the SDR basket since October 2016 which implies that it is treated as international currency that can determine the world capital market and the international trade.Since 1956,China is the trade surplus country with the rest of the world except in 1960,1974,1975,1978-80,1984-1993 respectively in which the trend of trade surplus has been stepping upswings.In the similar reason,China has been enjoying trade surplus with USA since 1993 -2019 which has been increasing too except in 2019.China imports 79 products from USA in which minerals,aircraft radars,semiconductors, medical disinfectants,metals,chemicals,petrochemicals and agricultural goods etc. are dominants. On the other hand,China exports to USA namely telephone and networks,data processing machines, Try-cycles,scooters,wheelers,toys,communication apparatus,electronic goods,television and so on.The huge trade deficit of USA with China creates tensions in the arena of international trade war and trade diversion in which the retaliation of tariff imposed by both USA and China emerged destruction of bilateral relation.Therefore,both USA and China had started to negotiate for settlement of tariff imposition where in July 2018,their tariff rates were the same amounting to 34billion US dollar which have turned into 200billion US dollar at 10% adopted by USA in 2018 September in comparison to 60 billion US dollar at 10% rate adopted by China .Lastly ,in 2019 May USA imposed 200billion USdollar at 25% rate of tariff but China imposed at the same amounting to 60 billion US dollar.Even, according to last agreement, China also fulfilled 2020 import commitment of buying an additional US$ 200 billion of US goods and services including US$ 36.5 billion US agricultural goods.USA is still adamant and abandoned the TPP agreement which displaced China from the world economic and political power.

In this context, the author tried to explore the Chinese trade patterns with USA during 1990 -2019 showing cyclical fluctuations of both export to USA and import from USAand even examined the cointegrating relation and vector error correction among the variables like Chinese export to USA and import from USA with GDP of China and USA, liquidity of China and USA,NEER and REER of China, FDI inflows of China and USA, and openness index of China respectively from 1990 to 2019.

II. Literature Review

There are huge economic literatures on the Sino-US trade patterns in many dimensions and even in the field of political economy analysis also I have studied a few articles related to the paper. Casey(2012)examined trade data between China and USA during 2000-2011and found that China tends to be a trade surplus country with US but US faced trade surplus with China in non-manufactured goods. China imports agricultural products,

Author had

cast-offs (scrap metal, waste paper, and the like) from USA, but China was the largest foreign market for U.S. exports of iron and steel waste and scrap etc. Exports of oil, gas, minerals and ores from the United States to China also grew substantially over this period which primarily attributed to exports of metal ores, and coal and petroleum gases, and has once again likely been driven by China's rapid development. China also imports aviation, motor cars, chemicals, minerals from USA. But China exports electronic goods, computers, toys, shoes, semiconductors, telephones, television, video game to USA in a bulk amount.

Autor et al. (2013) have shown empirically that rising imports from China have contributed significantly to falling manufacturing employment in the US where raising tariffs to bring manufacturing jobs back to the United States could be motivated.

Oxford Economics for US-China Business Council(2017) reviewed that US exports to China will rise to more than US$520 billion by 2030 and China is the leading purchaser of US agricultural goods.US manufacturing productivity increased by 40% from 2003 to 2016 which make less cost competitive of Chinese workers than USA which led to retention of jobs in manufacturing sector in USA.US export to China directly or indirectly supported 1.8 million jobs and US$ 165 billion GDP in 2015.Both China and US trade support 2.6 million jobs where jobs lost due to trade deficit.

Handley and Limao (2017) have estimated the boost to exports from China to the United States after accession of China to the US because of the reduction in uncertainty about possible US tariffs for Chinese exporters. They argue that one-third of the increase in exports from China to the US since the entry of China to the WTO can be related to reduced uncertainty about trade policy. Their methodology has not been applied to the current trade tensions because of lack of information on the probability of different trade policy scenarios.

Cerutti,Gopinath and Mohommad(2019) examined that US-China trade tensions have negatively affected consumers as well as producers in both countries.Tariff reduced trade,disrupted global supply chain and hampered the recovery in global growth in 2019.Trade diversion affected producer's channels. The relative aggregate demand and supply as macroeconomic factors in partner countries and their underlying drivers play a much bigger role than tariffs in determining bilateral trade balances.The new tariff agreements may reduce global GDP by 0.3% in the short run.

Nicita(2019) showed that trade war between China and USA led to trade diversion,lower trade,higher prices for consumers.The effects on sectoral level in machinery and communication equipment account 15 billion US$ in 2019.Trade diversion effects equal 21 billion US$ and loss of trade was found to be about 14 billion US$ in first half of 2019.

Flaaen and Pierce (2019) examined the impact of the higher US tariffs on manufacturing employment,disentangling three channels: rising employment because of more protection; falling employment because of higher prices of intermediate inputs making production in the US more expensive; falling employment because of retaliatory tariffs. They found that, at least in the short run, the last two negative channels were dominant, leading on net to a fall in manufacturing employment. As they observed, it might take time for the economy to adjust to the new situation and thus for the first positive channel to fully take effect.

Griswold (2019) explained that imposing "reciprocal tariffs", i.e. equalizing the tariffs imposed by the US and those faced by the US at the tariff line level, would be at odds with the principle of MFN and would raise the administrative burden of tariff policy considerably.

Bekkers and Schroeter(2020)argued that increase in tariff reduced the volume of trade between USA and China which led to trade diversion to Mexico,EU,Taiwan,Vietnam,Japan and Korea and trade diversion of agricultural produce went to Latin America,Australia and New Zealand.The direct effect of tariff increase on the global economy equals 0.1% reduction of global GDP. According to the simulations global GDP would fall by 0.13% within 2023.Taking into account uncertainty effects, the loss in global GDP would be much more considerable and increase to between 0.34% and 0.50%. Global trade is projected to fall by 0.7% without uncertainty effects and by between 1.5% and 2.1% taking into account uncertainty effects.

Steinbock(2020)analyzed US-China trade war in the tariff imposition front which began to multilateralise and diverted trade so that US negative trade balance with China is transformed into a threat in terms of IPR,technology innovation,sovereignty,and trade domination.Both USA and China agreed to a new agreement of trade pact that tariff impact must be limited to 0.5% of Chinese GDP and 0.8% of US GDP.At G-20 meeting agreement was that tariff must be 10% on US product from January1,2019 and China would buy agricultural, energy, industrialand other products from the United States to reduce the trade imbalance.

Brodzicki (2020)analysed Chinese and US export and import taking data for the period 2000M1-2019M12 and observed that their trends were non-linear having one structural break for both from 2008July to 2009February and significant seasonality where Chinese export coincided well with US import.US export has two peaks and import has one peak but Chinese export have two peaks and import have three peaks.US faced permanent deficit but China showed permanent surplus.

III. Methodology and Sources of data

The paper assumed that x=Chinese export to USA in million US$ at current prices,m=Chinese import from USA in million US$ at current prices,y_1=GDP of China in billion USDollars at current prices,y_2=GDP of USA in billion US$ at current prices,$NEER_1$=Nominal effective exchange rate of China with 2010=100,$REER_1$=real effective exchange rate of China with 2010=100,l_1=total international liquidity in trillion US dollar excluding gold at current prices,l_2=total international liquidity of USA in trillion US$ excluding gold in current prices,FDI_1=Foreign direct investment inflows in China in million US $ at current prices,FDI_2=foreign direct investment inflows of USA in million US $ at current prices.Openness=Openness index of China(%) which is calculated by the formula $\sum(x+m)/2/GDPx100$.

Data on Chinese export to USA and import from USA,NEER and REER andtotal international liquidity of both countries were collected from International Financial Statistic,IMF.Chinese GDP,FDI inflows and GDP and FDI inflows of USA were collected from the World Bank. Openness index have been calculated by author taking data on export, import and GDP from the UNCTAD.

Cointegration test and vector error corrections were calculated by applying Johansen (1988) methodology. Long run causality was verified from the cointegrating equations and short run causality was verified by using the Wald test (1943). Hamilton (2018) regression filter model was applied to decompose trends and cycles from the series.

The definition of REER and NEER are given below.

$$REER=\sum_{i=1}^{n}[\left(\frac{e}{e_i}\right)\left(\frac{p}{p_i}\right)]^{w_i}$$

Where n= number of countries,i=ith currency,e=exchange rate home,e_i=exchange rate ith country,p_i=price index of ith country by CPI,p=price index of the home country by CPI,w_i=weight (IMF 's SDR measure)

$$NEER=\sum_{i=1}^{n}[(\frac{s_i}{s_i^*})]^{w_i}$$

Where s_i = exchange rate of the national currency against ith currency

s_i^* = exchange rate of the national currency against the currency of the i during the base period

W_i=countries weight of the currency

IV. Important observations from the econometric models

[4.1]Decomposition of Chinese export to USA

Hamilton regression filter of Chinese export to USA from 1990 to 2019 has been estimated below.

$X_t=59.774+1.3429x_{t-4}-0.375x_{t-5}+0.1887x_{t-6}-0.1281x_{t-7}+v_t$

(3.48)* (2.36)* (-0.44) (0.22) (-0.206)

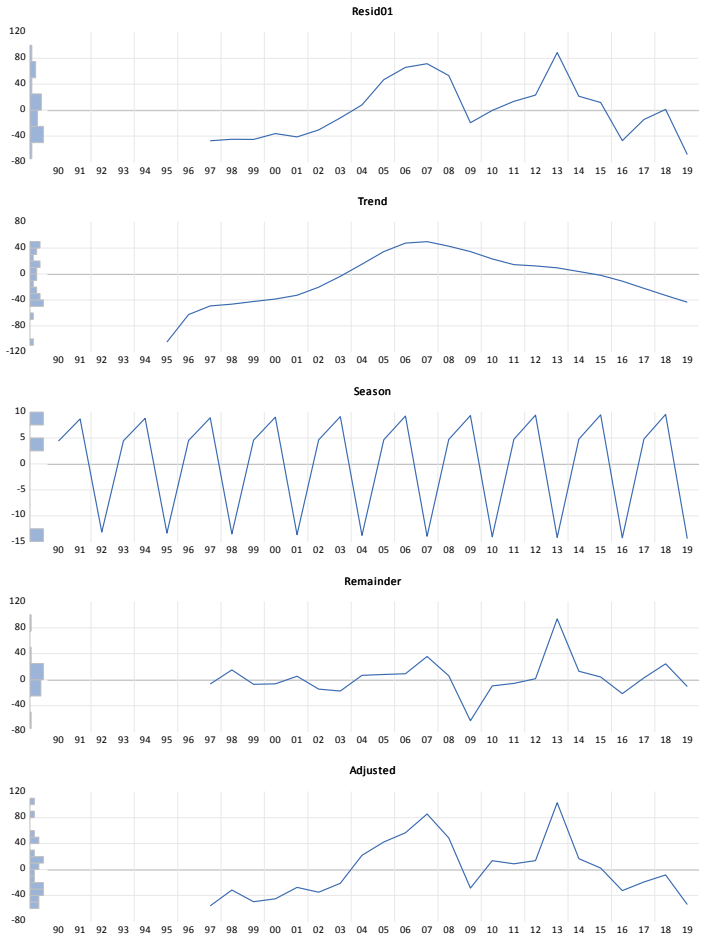
R^2=0.917,F=50.193*,AIC=10.77,SC=11.02,DW=0.664 where x=Chinese export to USA,*=significant at 5% level, n=23 after adjustment.The estimated regression filter is a good fit although the coefficients of x_{t-5},x_{t-6} and x_{t-7} became insignificant.

Therefore, the Hamilton residual $v_t=x_t-[59.774+1.3429x_{t-4}-0.375x_{t-5}+0.1887x_{t-6}-0.1281x_{t-7}]$

Through the method of STL,this residual is decomposed into cycle,trend,seasonal variation,remainder and seasonally adjusted cycle which are depicted in a panel of a diagram.In panel 1,the residual or v_t is plotted where it is consisted of two troughs and three peaks.The duration of recovery showed longer period than the period of recession and first cycle took 8 years,second cycle took 7 years and the third cycle took three years respectively.In the panel 2,the smooth trend cycle showed only one peak which is slowly declining after a gradual upswing.In the panel 3,the seasonal variation is v shaped with similar amplitudes.In panel4,the remainder has appeared with small peaks and troughs having short durations.In panel 5,the seasonally adjusted cycle is similar pattern with the residual cycle(Figure 1).

cyclical trend

Figure 1: The decomposition of Chinese export



Source-Plotted by author

The seasonal fluctuation of Hamilton filter of Chinese export to USA has been tested by the autocorrelation and partial autocorrelation functions which are moving from positive to negative values and having a single spike in PACF in lag-1 where all values have significant Q statistic.In Figure 2,both the ACF and PACF have been shown.

Figure 2.ACF and PACF of Hamilton filter

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.585	0.585	8.9492	0.003
		2	0.351	0.014	12.331	0.002
		3	0.099	-0.169	12.616	0.006
		4	-0.102	-0.156	12.931	0.012
		5	-0.031	0.212	12.961	0.024
		6	-0.130	-0.193	13.533	0.035
		7	-0.026	0.119	13.558	0.060
		8	-0.149	-0.281	14.411	0.072
		9	-0.248	-0.085	16.935	0.050
		10	-0.222	-0.026	19.106	0.039
		11	-0.304	-0.098	23.533	0.015
		12	-0.261	-0.195	27.091	0.007

Source- Plotted by author

This Hamilton filter has no heteroscedasticity problem which has observed by applying ARCH(2) method because nR^2=1.6711 whose probability of Chi-square(2)=0.43 which is accepted for H0=no heteroscedasticity where the estimated residuals squares are given below,

ε^2_t=2127.546+0.1052ε^2_{t-1}-0.2963ε^2_{t-2}

(2.95)* (0.43) (-1.21)

R^2=0.079, F=0.778, DW=2.00, n=21

[4.2]Decomposition of Chinese import from USA

Hamilton regression filter of Chinese import from USA from 1990 to 2019 is estimated below.

m_t=19.874+2.258m_{t-4}-0.6535m_{t-5}-0.1408m_{t-6}-0.7399m_{t-7}+v_t

(2.83)* (3.77)* (-0.61) (-0.13) (-0.71)

R^2=0.877,F=32.128*,AIC=9.047, SC=9.294,DW=0.706,n=23 after adjustment,*=significant

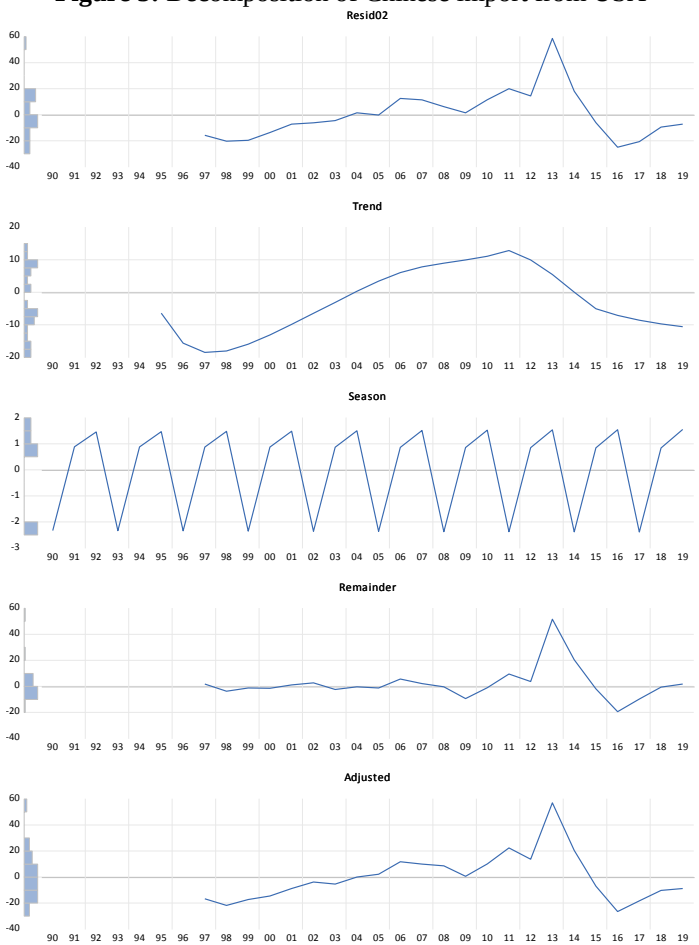
The estimated Hamilton regression filter has been shown a good fit but the coefficients of m_{t-5} ,m_{t-6} andm_{t-7} are insignificant.

Therefore,the residual of Hamilton filter becomes,

V_t= m_t-[19.874+2.258m_{t-4}-0.6535m_{t-5}-0.1408m_{t-6}-0.7399m_{t-7}]

This residual of Chinese import from USA has been decomposed by the method of STL and found cycle,trend,seasonal variation ,remainder and the seasonally adjusted cycle of the Chinese import from USA during 1990-2019 which is plotted in Figure 3.In panel 1,the residual series i.e. Hamilton cycle is plotted in which three peaks and four troughs have been found and a minimum 4 years was observed for a complete cycle.In panel 2,the smooth cyclical trend took a longer time to recovery and recession where a clear cycle was formed.In panel 3,the seasonal variation is v shaped with uniform amplitudes.In panel4,the remainder consists of short period upswings and downswings but in panel 5,the seasonally adjusted cycle is similar with the residual cycle showing long period upswings.

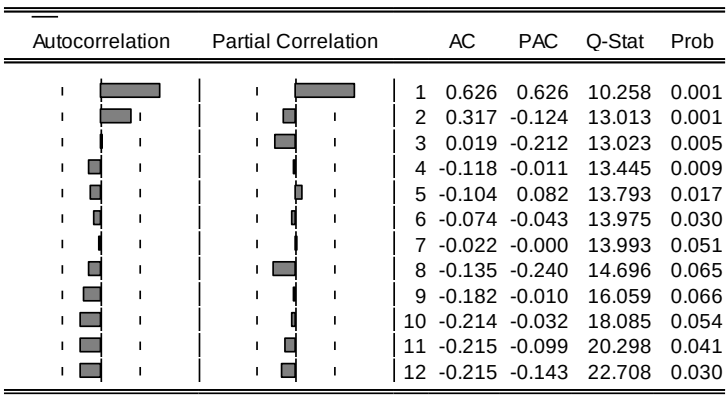
Figure 3: Decomposition of Chinese import from USA



Source- Plotted by author

The seasonal fluctuation of Chinese import from USA from 1990 to 2019 is verified by the autocorrelation and partial autocorrelation functions which showed that both have been changing from positive and negative values with single spike in PACF whose Q statistic are significant at 5% level and are plotted in Figure 4 below.

Figure 4:ACF and PACF of Chinese import from USA



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.626	0.626	10.258	0.001
		2	0.317	-0.124	13.013	0.001
		3	0.019	-0.212	13.023	0.005
		4	-0.118	-0.011	13.445	0.009
		5	-0.104	0.082	13.793	0.017
		6	-0.074	-0.043	13.975	0.030
		7	-0.022	-0.000	13.993	0.051
		8	-0.135	-0.240	14.696	0.065
		9	-0.182	-0.010	16.059	0.066
		10	-0.214	-0.032	18.085	0.054
		11	-0.215	-0.099	20.298	0.041
		12	-0.215	-0.143	22.708	0.030

Source- Plotted by author

The Hamilton filter of Chinese import from USA has no heteroscedasticity problem which is tested by ARCH(2) method where nR^2=0.02819,probability of Chi-Square(2)=0.986 which is accepted for H0=no heteroscedasticity where n=21,R^2=0.00134 and the estimated equation of residual square test are as follows.

ε^2_t=318.766+0.0298ε^2_{t-1}-0.22119ε^2_{t-2}

(1.56) (0.12) (-0.09)

R^2=0.0013, F=0.01209, DW=1.99, n=21

[4.3]Chinese trade balance with USA

Chinese export to USA has been increasing at the of 15.36% per annum from 1990 to 2019 which is significant at 5% level.The estimated linear trend equation is given below.

Log(x)=2.1755+0.15364t

(16.38)* (20.54)*

R^2=0.937,F=421.92,DW=0.191,*=significant at 5% level.n=30

On the contrary,the Chinese import from USA has been catapulting at the rate of 11.67% per annum significantly from 1990 to 2019.The linear trend line is estimated below.

log(m)=1.9361+0.11676t

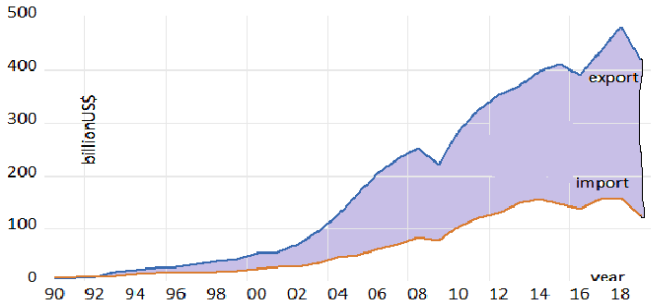
(25.63)* (27.44)*

R^2=0.964,F=753.46*,DW=0.336,n=30,*=significant at 5% level

China has been enjoying a huge trade balance surplus with USA since long period which has been stipulating year by year although in 2019 it was marginally declined, yet this trade surplus created an international trade tension between them as well as other major trading partners.In Figure 5,the Chinese trade surplus with USA is depicted where the area of grey colour has been widening gradually except in 2019.

2009,2016 and 2019.

Figure 5: Chinese trade surplus with USA



Source-Plotted by author

[4.4]Cointegration and vector error correction of Chinese export to USA

Johansen unrestricted cointegrated rank test among the first difference series of Chinese export to USA,GDP of China and USA,foreign direct investment inflows of China,International liquidity of USA,nominal and real effective exchange rate of China and trade openness of China during 1990-2019 revealed that the Trace statistic and Max Eigen statistic assured at least six cointegrating equations which are significant at least 5% level.In Table 1,the Eigen values,Trace statistic,Max Eigen statistic,their critical values with probabilities have been arranged neatly.

Table 1: Johansen cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.969324	327.5187	159.5297	0.0000
At most 1 *	0.943207	229.9588	125.6154	0.0000
At most 2 *	0.784297	149.6451	95.75366	0.0000
At most 3 *	0.747876	106.6973	69.81889	0.0000
At most 4 *	0.649782	68.11788	47.85613	0.0002
At most 5 *	0.598034	38.74029	29.79707	0.0036
At most 6	0.373213	13.22142	15.49471	0.1069
At most 7	0.005032	0.141248	3.841465	0.7070
		Max-Eigen Statistic		
None *	0.969324	97.55989	52.36261	0.0000
At most 1 *	0.943207	80.31365	46.23142	0.0000
At most 2 *	0.784297	42.94787	40.07757	0.0231
At most 3 *	0.747876	38.57939	33.87687	0.0127
At most 4 *	0.649782	29.37759	27.58434	0.0291
At most 5 *	0.598034	25.51887	21.13162	0.0113
At most 6	0.373213	13.08017	14.26460	0.0763
At most 7	0.005032	0.141248	3.841465	0.7070

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source-Computed by author

Now,the vector error correction model is estimated below.The estimated equations showed good fit but relations among the changes of variables with changes of previous years interpreted meaningful results.The change of Chinese export to USA with respect to previous year changes of GDP of China and USA were found negative and significant.The change of GDP of China with respect to previous year change of liquidity of US showed positive and significant.The change of GDP of US with respect to previous year change of openness of China was found negative and significant.The change of US liquidity with respect to previous year change of Chinese GDP showed positive and significant.The change of NEER and REER of China due to previous year change of US liquidity is negative and significant.The change of Chinese openness with respect to previous year NEER and REER of China were found significantly positive and negative respectively.All these results are shown in Table 2.

Table-2: Estimated VECM

Error Correction:	D(X)	D(Y1)	D(Y2)	D(FDI1)	D(L2)	D(NEER1)	D(REER1)	D(OPENNESS)
CointEq1	-0.06433	19.6642	-34.3789	369.331	-0.03992	0.26878	0.12629	-0.109137
	[-0.137]	[2.722]*	[-3.816]*	[1.741]	[-0.168]	[1.421]	[0.889]	[-2.392]*
CointEq2	-0.00525	-0.37103	0.76452	-6.16606	-0.01158	-0.00432	-0.00300	0.00281
	[-0.554]	[-2.529]*	[4.180]*	[-1.431]	[-2.415]*	[-1.125]	[-1.042]	[3.033]*
CointEq3	0.01041	-0.02723	0.15264	9.58527	0.00026	0.00415	0.00591	0.00035
	[1.572]	[-0.265]	[1.193]	[3.184]*	[0.078]	[1.549]	[2.936]*	[0.5537]
CointEq4	0.00017	-0.00844	-0.00670	-1.48160	0.00212	-0.00087	-0.00044	5.94E-05
	[0.131]	[-0.417]	[-0.265]	[-2.492]*	[3.212]*	[-1.641]	[-1.128]	[0.464]
CointEq5	1.0425	3.3969	6.0292	288.30	-0.8697	0.2741	0.1362	0.0378
	[2.721]*	[0.573]	[0.815]	[1.656]	[-4.485]*	[1.766]	[1.169]	[1.012]
CointEq6	0.2464	-5.2159	4.2732	-143.82	1.4479	-0.7365	-0.0874	0.0869
	[0.223]	[-0.305]	[0.200]	[-0.286]	[2.591]*	[-1.646]	[-0.260]	[0.806]
D(X(-1))	0.0466	-4.1903	44.265	-0.1274	-0.2420	-0.2327	-0.1077	0.0814
	[0.098]	[-0.573]	[4.857]*	[-0.0005]	[-1.012]	[-1.216]	[-0.750]	[1.765]
D(Y1(-1))	-0.0544	-0.3210	0.8038	-8.3704	0.0266	0.0092	0.0092	-0.0030
	[-2.318]*	[-0.883]	[1.772]	[-0.784]	[2.238]*	[0.966]	[1.289]	[-1.306]
D(Y2(-1))	-0.03001	-0.0715	-0.1931	-3.5951	-0.0006	-0.0040	-0.0035	8.98E-06
	[-3.693]*	[-0.568]	[-1.231]	[-0.973]	[-0.151]	[-1.228]	[-1.427]	[0.011]
D(FDI1(-1))	-0.0001	0.0148	-0.0481	0.5179	-0.0005	0.0006	0.0001	-7.16E-05

	[-0.138]	[0.713]	[-1.851]	[0.845]	[-0.804]	[1.164]	[0.381]	[-0.543]
D(L2(-1))	-0.4290	12.736	-7.1568	223.80	0.0580	-0.3571	-0.2968	0.0157
	[-1.195]	[2.292]*	[-1.032]	[1.371]	[0.319]	[-2.455]*	[-2.719]*	[0.450]
D(NEER1(-1))	0.8604	21.295	-25.914	-553.19	-0.6063	1.1567	0.0162	0.3555
	[0.659]	[1.054]	[-1.029]	[-0.933]	[-0.918]	[2.187]*	[0.040]	[2.788]*
D(REER1(-1))	-0.8881	-19.701	25.944	1165.3	0.7511	-1.4315	0.2593	-0.4853
	[-0.456]	[-0.654]	[0.691]	[1.319]	[0.763]	[-1.817]	[0.438]	[-2.555]*
D(OPENNESS(-1))	0.6939	90.476	-236.28	697.65	2.9337	-0.9767	-0.0746	-0.4882
	[0.185]	[1.564]	[-3.276]*	[0.410]	[1.551]	[-0.645]	[-0.065]	[-1.337]
C	55.204	718.72	-413.59	6206.7	-5.0468	0.4582	-0.3893	0.9794
	[5.484]*	[4.614]*	[-2.129]*	[1.357]	[-0.990]	[0.112]	[-0.127]	[0.995]
R-squared	0.8584	0.9085	0.8509	0.6652	0.8657	0.8232	0.7816	0.8405
F-statistic	5.6328	9.2220	5.3011	1.8454	5.9903	4.3238	3.3237	4.8943
Akaike AIC	8.3858	13.864	14.305	20.623	7.0240	6.5789	6.0048	3.7344
Schwarz SC	9.0995	14.577	15.019	21.337	7.7377	7.2926	6.7184	4.4480

Source-Calculated by author D=first difference

From the system equations of all the estimated equations of VECM,the cointegrating equations could be clearly identified where the cointegrating equations are as follows

[1]Z_{1t-1}=-0.0643x_{t-1}-10.528$REER_{1t-1}$-16.098$openness_{t-1}$+1194.169
(-0.137) (-28.21)* (-18.17)*

[2]Z_{2t-1}=19.664y_{1t-1}-342.11$REER_{1t-1}$-411.999$Openness_{t-1}$+37970.11
(2.72)* (-22.99)* (-11.53)*

[3]Z_{3t-1}=-34.378y_{2t-1}-402.418$REER_{1t-1}$-612.89$openness_{t-1}$+40153.82
(-3.81)* (-13.17)* (-8.45)*

[4]Z_{4t-1}=369.33FDI_{t-1}-3273.416$REER_{1t-1}$-4062.81$openness_{t-1}$+331887.2
(1.74) (-17.44)* (-9.12)*

[5]Z_{5t-1}=-0.0399l_{2t-1}+0.337$REER_{1t-1}$+3.869$Openness_{t-1}$-200.847
(-0.168) (0.81) (3.95)*

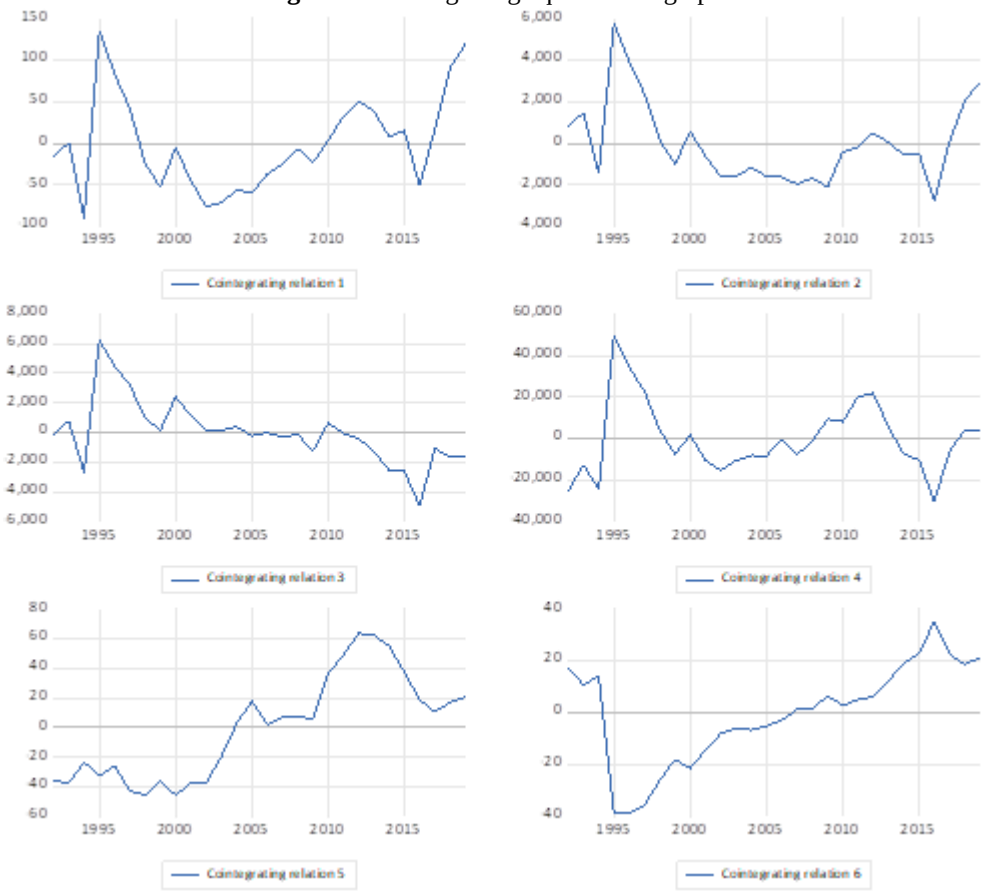
[6]Z_{6t-1}=0.268$NEER_{1t-1}$+0.512$REER_{1t-1}$+1.832$openness_{t-1}$-190.653
(1.42) (1.70) (2.56)*

The cointegrating equations,[1],[3] and,[5] have been approaching towards equilibrium in which equation [3] is significant because all the t values of coefficients are significant at 5% level and other equations are insignificant.The speed of adjustment was found as 3437% per year significantly.

Equation [1] revealed that there are long run causalities from REER and openness of China to the Chinese export to USA. It is statistically not significant at 5% level.The equation [3] states that there are long run causalities from REER and openness of China to the GDP of USA which are statistically significant at 5% level,and equation [5] implies that there are long run causalities from REER and openness of China to the liquidity of USA which are insignificant at 5% level.

The cointegrating equations have been plotted in Figure 6 where the 3rd figure tends to equilibrium significantly.

Figure 6: Cointegrating equations in graph



Source-Plotted by author

From the Wald test of all the system equations,it revealed that there are short run causalities from GDP of China to Chinese export to USA and liquidity of USA respectively which have short causal causalities to Chinese GDP and REER.Again,Chinese NEER and REER have short causalities with openness of China.There are short run causalities from Chinese export to USA and Chinese openness to Chinese GDP.Even,US GDP showed short run causality to Chinese export to USA.All these short run causalities have been arranged in Table 3.

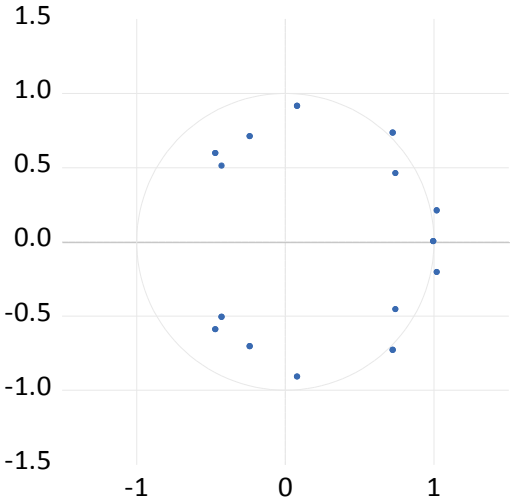
Table 3: Short run causalities.

Causality from ….. to ….	Chi-Square(1)	Prob	H0=no causality
GDP of china to export of china to USA	5.374	0.02	rejected
GDP of USA to export of china to USA	13.644	0.00	rejected
Liquidity of USA to GDP of China	5.255	0.0219	rejected
Chinese export to USA to GDP of China	25.593	0.00	rejected
Openness of China to GDP of China	10.736	0.001	rejected
GDP of China to US liquidity	5.0107	0.025	rejected
US liquidity to REER of China	7.395	0.006	rejected
Chinese NEER to openness of China	7.777	0.005	rejected
Chinese REER to openness of China	6.529	0.0106	rejected

Source-Calculated by author

The VECM is unstable and nonstationary because the characteristics polynomial consists of 16 roots in which two roots are one which lie on the unit circle, four roots are greater than one and lie outside the unit circle, and ten roots are less than one which lie inside the unit circle. The unit circle is given below in Figure 7.

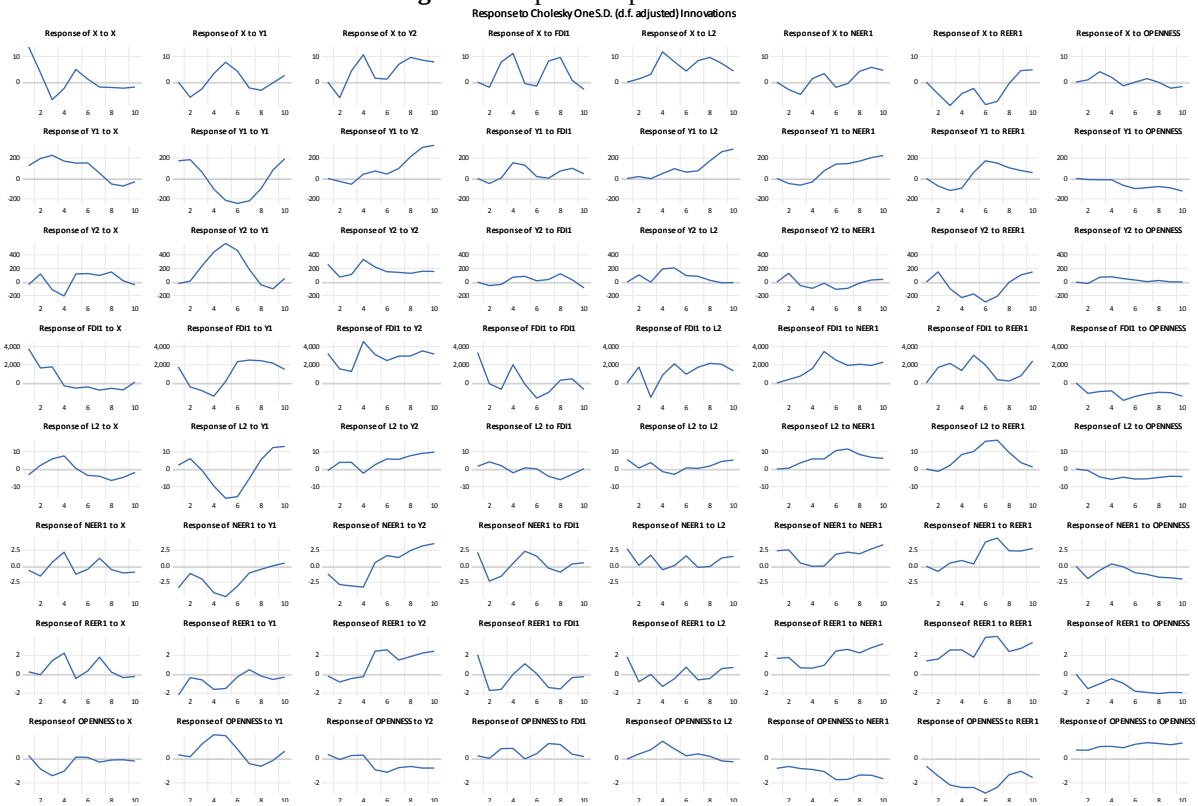
Figure 7: Unit circle



Source- Plotted by author

The impulse response functions measured by Cholesky one standard deviation innovations revealed that the responses of GDP,foreign direct investment inflows, nominal and real effective exchange rate and openness of China, and liquidity of USA to the Chinese export to USA approach to equilibrium.The response of GDP and openness of China and liquidity of USA to FDI of China move to equilibrium.The GDP and openness of China and liquidity of USA to REER of China tend to equilibrium.The response of Chinese export to USA and GDP of USA to openness of China move to equilibrium.But all the responses are non-stationary.(Figure 8)

Figure 8: Impulse response functions.



Source-Plotted by author.

[4.5]Cointegration and vector error correction of Chinese import from USA

Johansen unrestricted cointegrated rank test among the first difference series of Chinese import from USA,GDP of China and USA, foreign direct investment inflows of China, international liquidity of China, nominal and real effective exchange rate of China and trade openness of China during 1990-2019 revealed that

the Trace statistic confirmed at least six cointegrating equations and Max Eigen statistic assured at least four cointegrating equations which are significant at least 5% level. In Table 4, the Eigen values, Trace statistic, Max Eigen statistic, their critical values with probabilities have been arranged clearly.

Table 4: Johansen cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.972521	332.1831	159.5297	0.0000
At most 1 *	0.916999	231.5412	125.6154	0.0000
At most 2 *	0.893819	161.8521	95.75366	0.0000
At most 3 *	0.774021	99.05910	69.81889	0.0001
At most 4 *	0.605725	57.41434	47.85613	0.0049
At most 5 *	0.474332	31.35456	29.79707	0.0328
At most 6	0.376197	13.34819	15.49471	0.1026
At most 7	0.004788	0.134392	3.841465	0.7139
		Max-Eigen Statistic		
None *	0.972521	100.6418	52.36261	0.0000
At most 1 *	0.916999	69.68916	46.23142	0.0000
At most 2 *	0.893819	62.79298	40.07757	0.0000
At most 3 *	0.774021	41.64476	33.87687	0.0049
At most 4	0.605725	26.05978	27.58434	0.0773
At most 5	0.474332	18.00638	21.13162	0.1296
At most 6	0.376197	13.21379	14.26460	0.0728
At most 7	0.004788	0.134392	3.841465	0.7139

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source-Computed by author

Now, the vector error correction model is estimated below. The estimated equations showed good fit but relations among the changes of variables with changes of previous years interpreted meaningful results. The change of Chinese import from USA with respect to previous year changes of GDP of China was found negative and significant. It is positively related with changes in NEER and negatively related with change of REER of previous years. Even it is negatively related with changes of liquidity and FDI inflows of China of previous period. The change of GDP of China with respect to previous year change of openness of china showed negative and significant. The change of GDP of USA with respect to previous year change of openness of China and liquidity of China were found positive and significant. The change of Chinese openness with respect to previous year NEER and REER of China were found significantly positive and negative respectively. All these results are shown in Table 5.

Table-5: Estimated VECM

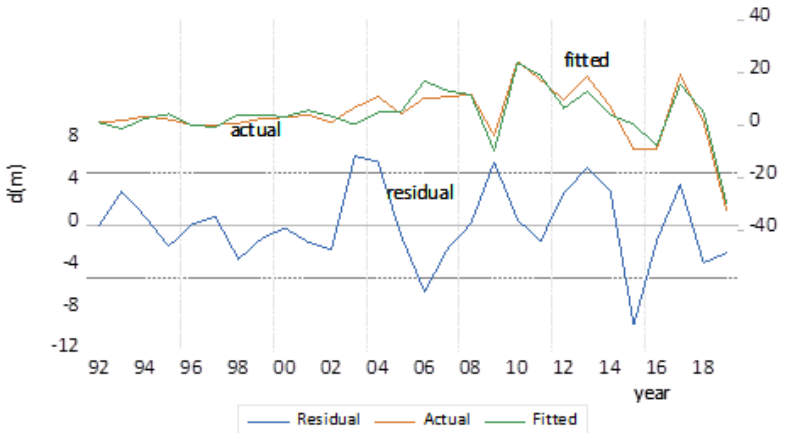
Error Correction:	D(M)	D(Y1)	D(Y2)	D(NEER1)	D(REER1)	D(FDI2)	D(L1)	D(OPENNESS)
CointEq1	-2.2973	-89.944	79.413	0.8469	0.9398	818.86	-18.460	-0.0751
	[-4.426]*	[-7.559]*	[2.165]	[1.364]	[2.442]*	[0.083]	[-0.499]	[-0.482]
CointEq2	0.0162	0.7924	-0.7169	-0.0069	-0.0075	-29.759	0.1437	0.0005
	[3.874]*	[8.249]*	[-2.421]*	[-1.378]	[-2.429]*	[-0.376]	[0.481]	[0.443]
CointEq3	-0.0067	0.1855	-0.0237	0.0047	0.0032	-15.910	0.0181	0.0004
	[-3.044]*	[3.626]*	[-0.150]	[1.793]	[1.964]	[-0.377]	[0.114]	[0.621]
CointEq4	-0.6856	3.7457	-7.0542	0.2490	0.2713	-4949.3	-3.4307	-0.0196
	[-3.729]*	[0.888]	[-0.543]	[1.132]	[1.991]	[-1.425]	[-0.261]	[-0.356]
D(M(-1))	0.9505	62.158	-69.760	0.1184	-0.2437	-7822.5	22.458	-0.0891
	[2.027]*	[5.783]*	[-2.105]*	[0.211]	[-0.701]	[-0.883]	[0.672]	[-0.633]
D(Y1(-1))	-0.0276	-0.0959	1.1943	1.63E-05	0.0023	129.67	-0.1929	-0.0015
	[-4.700]*	[-0.712]	[2.875]*	[0.002]	[0.536]	[1.168]	[-0.460]	[-0.897]
D(Y2(-1))	-0.0034	0.0257	-0.5333	0.0024	0.0011	-51.561	0.0078	-0.00103
	[-0.932]	[0.303]	[-2.036]*	[0.554]	[0.400]	[-0.736]	[0.029]	[-0.925]
D(NEER1(-1))	1.0640	3.9490	4.5872	1.6488	0.5996	5002.01	10.227	0.2374
	[3.397]*	[0.550]	[0.207]	[4.400]*	[2.582]*	[0.845]	[0.458]	[2.524]*
D(REER1(-1))	-1.5101	2.0242	-2.7282	-1.6278	-0.3299	-9780.08	-14.1094	-0.34125
	[-3.156]*	[0.184]	[-0.080]	[-2.844]*	[-0.930]	[-1.082]	[-0.413]	[-2.375]*
D(FDI2(-1))	-5.50E-05	-0.0004	0.0030	1.72E-06	-7.10E-06	0.2811	0.00037	2.05E-06
	[-2.652]*	[-1.046]	[2.057]*	[0.069]	[-0.461]	[0.718]	[0.256]	[0.330]
D(L1(-1))	-0.0237	-0.1691	1.1750	-0.0152	-0.0059	-38.718	-0.1429	0.0018
	[-2.687]*	[-0.834]	[1.880]	[-1.442]	[-0.912]	[-0.231]	[-0.226]	[0.697]

D(Openness(-1))	-1.7794	-53.090	159.56	-1.3939	0.1361	2048.5	-45.694	0.2872
	[-1.837]	[-2.391]*	[2.332]*	[-1.203]	[0.189]	[0.112]	[-0.662]	[0.988]
C	18.753	254.21	309.41	2.3359	2.4112	24809.8	112.86	1.8144
	[6.024]*	[3.562]*	[1.406]	[0.627]	[1.045]	[0.422]	[0.508]	[1.941]
R-squared	0.8795	0.9693	0.6948	0.7646	0.8017	0.4020	0.1300	0.7700
F-statistic	9.1274	39.515	2.8463	4.0601	5.0562	0.8403	0.1867	4.1853
Akaike AIC	6.3638	12.628	14.879	6.7224	5.7651	26.055	14.896	3.9576
Schwarz SC	6.9823	13.246	15.498	7.3409	6.3836	26.674	15.514	4.5761

Source-Calculated by author D=first difference

The system equation one is estimated where all the t values like four error correction terms and other variables like GDP ,liquidity,NEER,REER of China,and FDI inflows of USA have been found significant so that the change of Chinese import from USA has been significantly approaching towards equilibrium where major obstacles are GDP of USA and openness of China which prevented to reach the equilibrium which is clearly observed in Figure 9 below.

Figure 9: The nature of d(m)



Source- Plotted by author

The system equations of VECM released at least four cointegrating equations in which equation 1 states that there are long run causalities from REER,total liquidity and openness of China and FDI inflows of USA to the Chinese imports from USA in which all coefficients are significant at 5% level which implies that it is approaching towards equilibrium.The same is true for the causality to Chinese GDP in the cointegrating equation 2.The cointegrating equation 3 is significant but it is divergent and there are long run causalities from REER,total liquidity and openness of China and FDI inflows of USA to the GDP of USA.The 4th cointegrating equation is also divergent and insignificant although t values of coefficients of REER,liquidity and openness of China and FDI inflows of USA showed significant.All the cointegrating equations have been estimated and shown below.

$[1]Z_{1t-1}$=-2.297m_{t-1}+16.433$REER_{1t-1}$-0.00034FDI_{2t-1}-0.185l_{1t-1}+5.988$openness_{t-1}$-1479.72
(-4.42)* (7.27)* (-3.63)* (-9.15)* (2.97)*

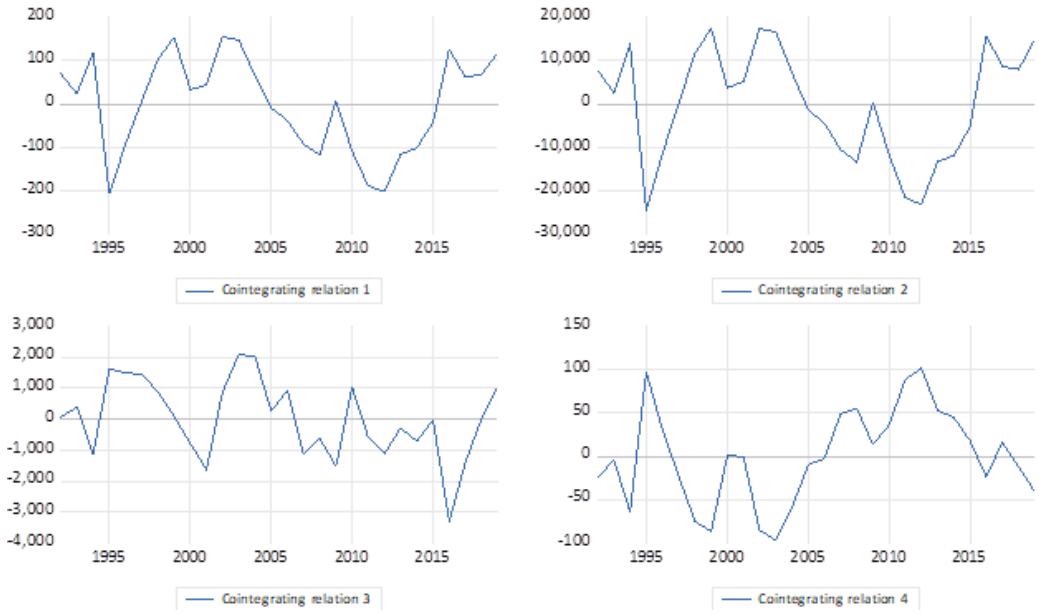
$[2]Z_{2t-1}$=-89.944y_{1t-1}+1913.057$REER_{1t-1}$-0.0373FDI_{2t-1}-19.941l_{1t-1}+829.077$Openness_{t-1}$-174573.9
(-7.559)* (7.35)* (-3.40)* (-8.56)* (3.57)*

$[3]Z_{3t-1}$=79.413y_{2t-1}-100.42$REER_{1t-1}$-0.0159FDI_{2t-1}-1.2109l_{1t-1}-311.26$Openness_{t-1}$+87.031
(2.165)* (-3.46)* (-13.04)* -4.67)* (-12.06)*

$[4]Z_{4t-1}$=0.8469$NEER_{1t-1}$-10.152$REER_{1t-1}$+0.00035FDI_{2t-1}+0.0814l_{1t-1}-4.692$Openness_{t-1}$+814.031
(1.364) (-7.66)* (6.38)* (6.87)* (-3.98)*

In Figure 10,the cointegrating equations have been depicted where first and second figures approached towards zero but finally turned away from zero because the VECM is unstable and nonstationary and the third and fourth series went away from zero divergently.

Figure 10: Nature of cointegrating equations



Source: Plotted by author

From the system equation and examining by Wald test,it was revealed that there are short causalities from Chinese GDP,NEER and liquidity and FDI inflows of USA to the Chinese import from USA.Openness and import from USA to China have short run causalities with Chinese GDP.Even,GDP of USA has short run causalities from Chinese GDP and openness and liquidity of USA.Two-way short run causalities were also observed among Chinese NEER and REER which have also short run causalities with openness of China.All the short run causalities are shown in Table 6.

Table 6: Short run causalities

Causality from ….. to ….	Chi-Square(1)	Prob	H0=no causality
GDP of China to Chinese import from USA	22.0965	0.00	rejected
NEER of China to Chinese import from USA	11.5438	0.00	rejected
FDI inflows of USA to Chinese import from USA	7.0366	0.008	rejected
Liquidity of China to Chinese import from USA	7.2204	0.007	rejected
Chinese import from USA to Chinese GDP	33.448	0.00	rejected
Chinese openness to Chinese GDP	5.720	0.016	rejected
Chinese GDP to US GDP	8.267	0.004	rejected
FDI inflows of USA to GDP of USA	4.2223	0.039	rejected
Chinese openness to GDP of USA	5.439	0.019	rejected
Chinese REER to Chinese NEER	8.0887	0.0045	Rejected
Chinese NEER to Chinese REER	6.671	0.0098	rejected
Chinese NEER to Chinese openness	6.374	0.0116	rejected
Chinese REER to Chinese openness	5.643	0.0175	rejected

Source-Calculated by author

The VECM consists of 16 inverse roots of AR characteristic polynomial in which four roots are equal to one,one root is greater than one and the rest eleven roots are less than one,all of which are shown below in Table7.

Table 7: Values of roots

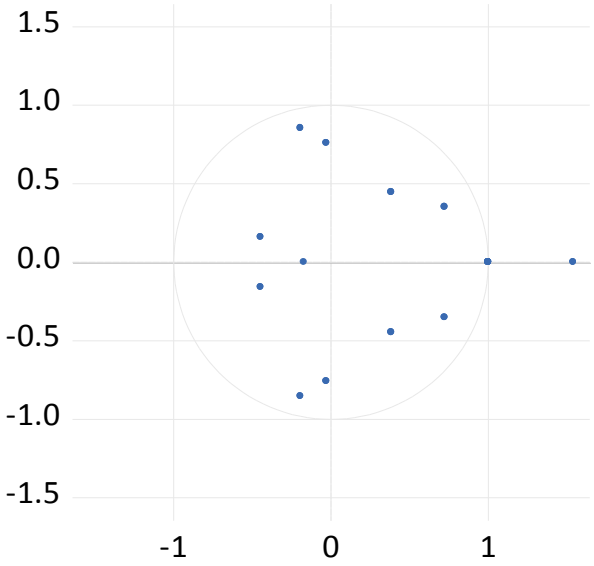
Root	Modulus
1.541831	1.541831
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
-0.193323 - 0.853948i	0.875557
-0.193323 + 0.853948i	0.875557
0.723142 - 0.352382i	0.804429
0.723142 + 0.352382i	0.804429
-0.028062 - 0.758096i	0.758615
-0.028062 + 0.758096i	0.758615

0.384622 - 0.445366i	0.588460
0.384622 + 0.445366i	0.588460
-0.445605 - 0.158655i	0.473006
-0.445605 + 0.158655i	0.473006
-0.171712	0.171712

Source:Calculated by author

If all the roots have been plotted in the unit circle,then one root lies outside the unit circle,four roots lie on the unit circle and the rest 11 roots lie inside the unit circle.It implies that the model is nonstationary and unstable.

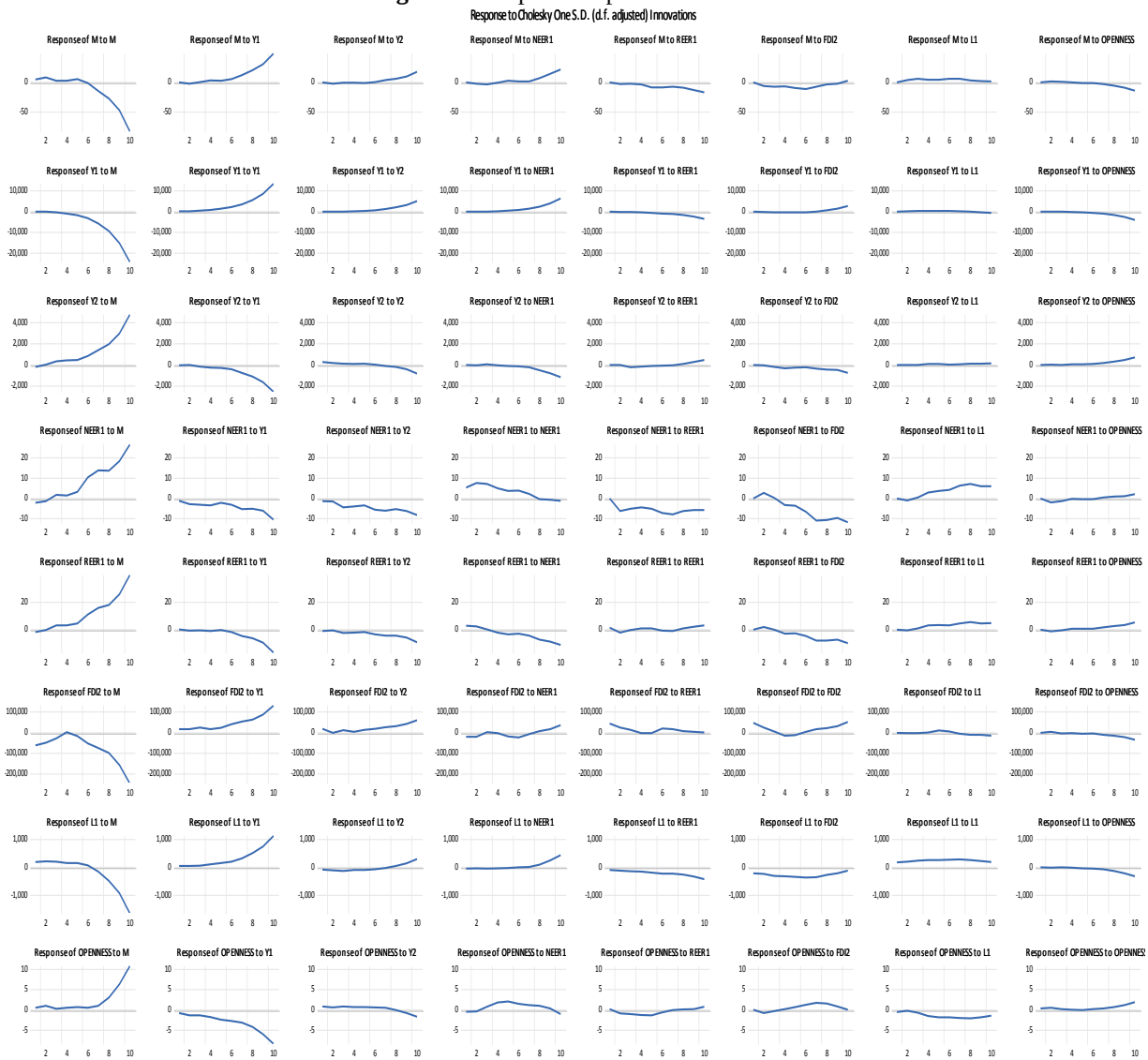
Figure 11: Unit circle



Source:Plotted by author

Impulse response functions measured by response to Cholesky one standard deviation innovations revealed that response of openness of China to REER and NEER of China and FDI inflows of USA moved towards equilibrium.Response of Chinese import from USA to FDI inflows of USA and total liquidity of China approach to equilibrium.Response of FDI inflows of USA to REER of China tends to equilibrium.Responses of both GDP of China and USA to total liquidity of China moved to equilibrium and response of Chinese liquidity FDI inflows of USA tends to equilibrium.All these responses have been shown in the Figure12 below.

Figure 12: Impulse response functions



Source:Plotted by author

V. Limitations and future scope of research

The study suffers from certain limitations too.Firstly,the period of study should be longer because yearly data were taken so that observations would be more accurate and meaningful.If the paper includes monthly or quarterly data, then Hamilton filter through census x-13 package could be applied instead of STL method.Secondly,if the paper included tariff rate,share price index,trade intensity and diversification index then additional observations could enrich the outcome of the paper. Even, the political factors may be included as dummy variable that might give clear signal about the stability of export or import market of China. Thus, there are enough scope for future research in these areas.

VI. Conclusion and remarks

The paper concludes that Chinese export to USA during 1990-2019 consists of three peaks and two troughs and one cycle took to complete at least eight years.Seasonal variation is v shaped and in smooth trend cycle one peak is clearly visible according to Hamilton regression filter.Seasonal variation is tested by ACF and PACF and moreover,no heteroscedasticity was found.Similarly,Chinese import from USA during 1990-2019 showed three peaks and four troughs where one cycle took at least four years and the trend cycle showed two peaks and the seasonal variation is found v shaped and seasonality was verified by ACF and PACF and there was no heteroscedasticity problem.Chinese export to USA has been rising by 15.36% per year and import from USA has been stepping up at the rate of 11.67% per year and the trade surplus has been stipulating continuously except in 2019.

cyclical trend

took at least eight years for completion

Chinese export to USA,GDP of China and USA,FDI inflows of China,openness,nominal effective exchange rate and real effective exchange rate of China and total liquidity of USA during 1990-2019 have six cointegrating equations.The estimated VECM revealed that there are long run causalities from real effective exchange rate and openness of China to the Chinese export to USA significantly.There are short run causalities from GDP of China and USA to Chinese export to USA and from Chinese export to GDP of China,from openness of China to GDP of China and from nominal and real effective exchange rates of China to openness of China respectively.The VECM is unstable and non-stationary.Similarly,Chinese import from USA,GDP of China and USA,Chinese nominal and real effective exchange rates,total liquidity,openness and FDI inflows of USA have at least four significant cointegrating equations.VECM revealed that there are long run causalities from real effective exchange rate,openness,total liquidity of China and FDI inflows of USA to the Chinese import from USA significantly.Moreover,there are short run causalities from GDP,nominal effective exchange rate,total liquidity of China and FDI inflows of USA to the Chinese import from USA respectively.The VECM is unstable and non-stationary.

Last but not the least,during 1-1700,both China and India were the leading dominant international economies and after 2030 the history may repeat itself. The Chinese Yuan may dominate lion's share of international trade in the offing. The problem is that the huge current account surplus of China with the US and the rest of the world has been knocking the USA, Europe and other dominant economies randomly and the hegemony of USA and Euro Area have been disrupted. The international monetary system shows a new dimension because Yuan is included in SDR basket, China enters into WTO,IMF and World Bank.New paradigm shift in international trade and international liquidity have been emerged but its not a trade war.

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