T.C

CUKUROVA UNIVERSITY

FACULTY OF ECONOMICS AND ADMINISTRATIVE SCIENCES

ECONOMETRICS

APPLIED ECONOMETRICS II HOMEWORK

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ABSTRACT

Analysis that I made includes three variables, total production level as dependent and computer and high technology product productions I wanted to study these two variables change in time how is going to affect the total production. The data is taken from TCMB website with period of first month of 2010 to second month of 2022 so we can say that the data is up to date. Study investigates the stationary of the series with unit roots test, correlograms VAR analysis, Cointegration tests and impulse response analysis.

Introduction

With the rapid advancement of technology, a new industrial production field formed and this affected countries characteristics of production in this study I chose 2 dependent variables which are the production of High technology and Computer components because world becoming more industrialized over the years and Turkey's characteristics of production changed with it. As the study states the increase in the total production has a positive effect on production of computer parts on the other hand high technology products has a negative relationship so we can say that Turkey's produces other goods as our production level increases and it is found that three of the variables tends to increase together in last 12 years.

Analysis

In my research, I wanted to see the overall impact of high technology products and computers' electronic and optic components on aggregate production level in Turkey. The data is downloaded from EVDS website, and it is real and up to date with 146 observations. The interval of the data is 2010M01 and 2022M02. Before I started to make an analysis on EViews first, I turned the data in logarithmic form and seasonally adjusted it.

Dependent Variable: LN_TOTAL_SA
Method: Least Squares
Date: 04/30/22 Time: 23:13
Sample: 2010M01 2022M02
Included observations: 146

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.454371	0.063059	38.92151	0.0000
LN_HIGHTECH_SA	0.326668	0.044631	7.319324	0.0000
LN_COMPUTER_SA	0.138278	0.042786	3.231865	0.0015

R-squared	0.890777	Mean dependent var	4.597906
Adjusted R-squared	0.889250	S.D. dependent var	0.194803
S.E. of regression	0.064829	Akaike info criterion	-2.613800
Sum squared resid	0.600996	Schwarz criterion	-2.552493
Log likelihood	193.8074	Hannan-Quinn criter.	-2.588890
F-statistic	583.1264	Durbin-Watson stat	1.136645
Prob(F-statistic)	0.000000		

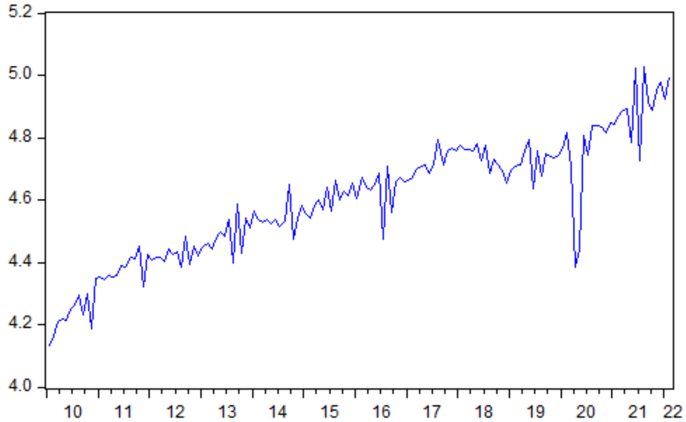
Our first regression equation output is shown above. Adjusted R-squared value tells us approximately 0.889% of the dependent variable is explained by the independent variables which is production of high technology goods and computer components. Probability levels are smaller than 0.05 so we can conclude that our model is significant at 5% significancy level. Durbin Watson statistics with 1.136645 tells us that there might be a positive autocorrelation problem because the value is closer the 1.

Spurious Regression

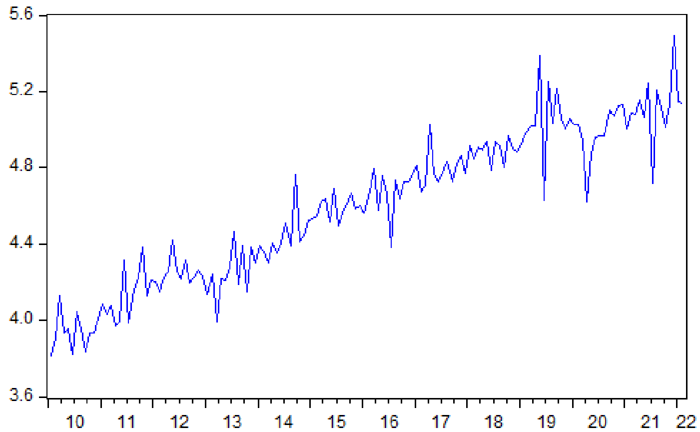
R-squared value is smaller than Durbin Watson statistics.

0.89<1.14

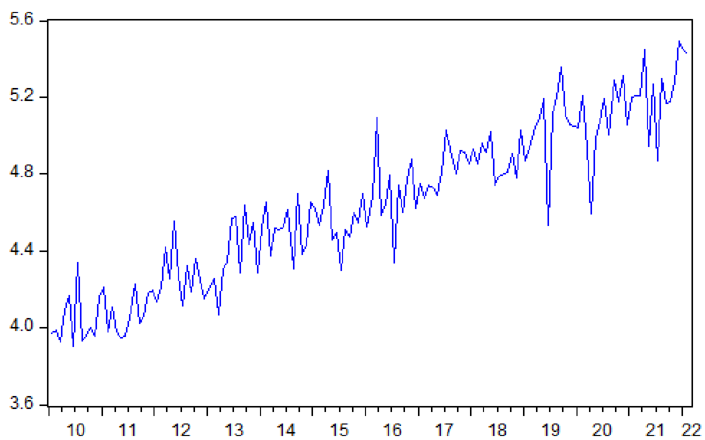
LN_TOTAL_SA



LN_HIGHTECH_SA

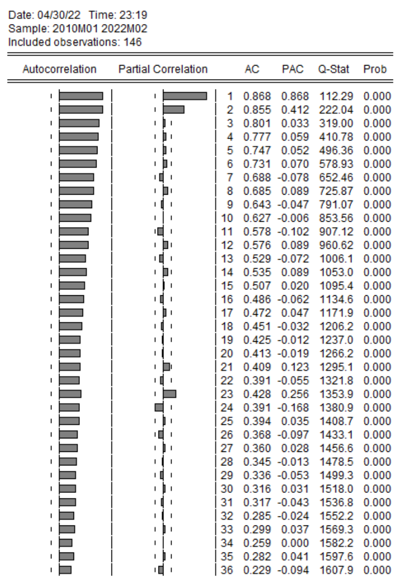


LN_COMPUTER_SA



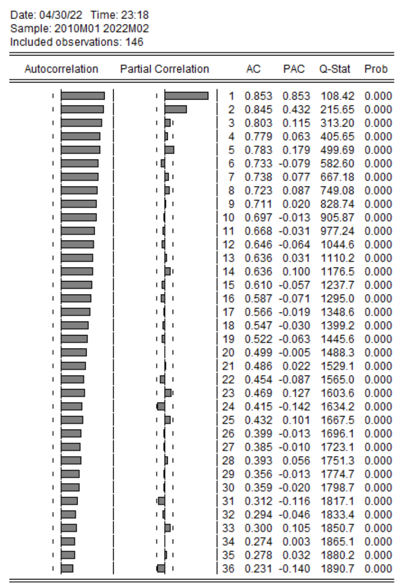
As we see above main direction of total production high technology goods and computer components are upwards sometimes, we observe fluctuations and impacts of unexpected factors like pandemics in 2020 but after all a steady increment can be spotted.

Correlograms



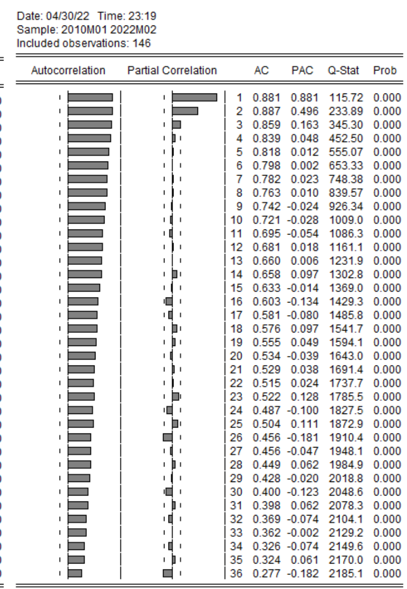
Date: 04/30/22 Time: 23:19
Sample: 2010M01 2022M02
Included observations: 146

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.868	0.868	112.29	0.000
		2	0.855	0.412	222.04	0.000
		3	0.801	0.033	319.00	0.000
		4	0.777	0.059	410.78	0.000
		5	0.747	0.052	496.36	0.000
		6	0.731	0.070	578.93	0.000
		7	0.688	-0.078	652.46	0.000
		8	0.685	0.089	725.87	0.000
		9	0.643	-0.047	791.07	0.000
		10	0.627	-0.006	853.56	0.000
		11	0.578	-0.102	907.12	0.000
		12	0.576	0.089	960.62	0.000
		13	0.529	-0.072	1006.1	0.000
		14	0.535	0.089	1053.0	0.000
		15	0.507	0.020	1095.4	0.000
		16	0.486	-0.062	1134.6	0.000
		17	0.472	0.047	1171.9	0.000
		18	0.451	-0.032	1206.2	0.000
		19	0.425	-0.012	1237.0	0.000
		20	0.413	-0.019	1266.2	0.000
		21	0.409	0.123	1295.1	0.000
		22	0.391	-0.055	1321.8	0.000
		23	0.428	0.256	1353.9	0.000
		24	0.391	-0.168	1380.9	0.000
		25	0.394	0.035	1408.7	0.000
		26	0.368	-0.097	1433.1	0.000
		27	0.360	0.028	1456.6	0.000
		28	0.345	-0.013	1478.5	0.000
		29	0.336	-0.053	1499.3	0.000
		30	0.316	0.031	1518.0	0.000
		31	0.317	-0.043	1536.8	0.000
		32	0.285	-0.024	1552.2	0.000
		33	0.299	0.037	1569.3	0.000
		34	0.259	0.000	1582.2	0.000
		35	0.282	0.041	1597.6	0.000
		36	0.229	-0.094	1607.9	0.000



Date: 04/30/22 Time: 23:18
Sample: 2010M01 2022M02
Included observations: 146

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.853	0.853	108.42	0.000
		2	0.845	0.432	215.65	0.000
		3	0.803	0.115	313.20	0.000
		4	0.779	0.063	405.65	0.000
		5	0.783	0.179	499.69	0.000
		6	0.733	-0.079	582.60	0.000
		7	0.738	0.077	667.18	0.000
		8	0.723	0.087	749.08	0.000
		9	0.711	0.020	828.74	0.000
		10	0.697	-0.013	905.87	0.000
		11	0.668	-0.031	977.24	0.000
		12	0.646	-0.064	1044.6	0.000
		13	0.636	0.031	1110.2	0.000
		14	0.636	0.100	1176.5	0.000
		15	0.610	-0.057	1237.7	0.000
		16	0.587	-0.071	1295.0	0.000
		17	0.566	-0.019	1348.6	0.000
		18	0.547	-0.030	1399.2	0.000
		19	0.522	-0.063	1445.6	0.000
		20	0.499	-0.005	1488.3	0.000
		21	0.486	0.022	1529.1	0.000
		22	0.454	-0.087	1565.0	0.000
		23	0.469	0.127	1603.6	0.000
		24	0.415	-0.142	1634.2	0.000
		25	0.432	0.101	1667.5	0.000
		26	0.399	-0.013	1696.1	0.000
		27	0.385	-0.010	1723.1	0.000
		28	0.393	0.056	1751.3	0.000
		29	0.356	-0.013	1774.7	0.000
		30	0.359	-0.020	1798.7	0.000
		31	0.312	-0.116	1817.1	0.000
		32	0.294	-0.046	1833.4	0.000
		33	0.300	0.105	1850.7	0.000
		34	0.274	0.003	1865.1	0.000
		35	0.278	0.032	1880.2	0.000
		36	0.231	-0.140	1890.7	0.000



Date: 04/30/22 Time: 23:19
Sample: 2010M01 2022M02
Included observations: 146

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.881	0.881	115.72	0.000
		2	0.887	0.496	233.89	0.000
		3	0.859	0.163	345.30	0.000
		4	0.839	0.048	452.50	0.000
		5	0.818	0.012	555.07	0.000
		6	0.798	0.002	653.33	0.000
		7	0.782	0.023	748.38	0.000
		8	0.763	0.010	839.57	0.000
		9	0.742	-0.024	926.34	0.000
		10	0.721	-0.028	1009.0	0.000
		11	0.695	-0.054	1086.3	0.000
		12	0.681	0.018	1161.1	0.000
		13	0.660	0.006	1231.9	0.000
		14	0.658	0.097	1302.8	0.000
		15	0.633	-0.014	1369.0	0.000
		16	0.603	-0.134	1429.3	0.000
		17	0.581	-0.080	1485.8	0.000
		18	0.576	0.097	1541.7	0.000
		19	0.555	0.049	1594.1	0.000
		20	0.534	-0.039	1643.0	0.000
		21	0.529	0.038	1691.4	0.000
		22	0.515	0.024	1737.7	0.000
		23	0.522	0.128	1785.5	0.000
		24	0.487	-0.100	1827.5	0.000
		25	0.504	0.111	1872.9	0.000
		26	0.456	-0.181	1910.4	0.000
		27	0.456	-0.047	1948.1	0.000
		28	0.449	0.062	1984.9	0.000
		29	0.428	-0.020	2018.8	0.000
		30	0.400	-0.123	2048.6	0.000
		31	0.398	0.062	2078.3	0.000
		32	0.369	-0.074	2104.1	0.000
		33	0.362	-0.002	2129.2	0.000
		34	0.326	-0.074	2149.6	0.000
		35	0.324	0.061	2170.0	0.000
		36	0.277	-0.182	2185.1	0.000

Interpretation of Correlograms

$$H_0: The\ series\ has\ no\ unit\ root\ (The\ series\ is\ stationry)$$

Autocorrelation coefficient is not significant

$$H_A: The\ series\ has\ a\ unit\ root\ (The\ series\ is\ non-stationary)$$

Autocorrelation coefficient is significant

To determine whether the series has a unit root or not we check probability values. For 5% significancy level all dependent and independent variables' probability values are smaller than 0.05 so we reject the null hypothesis. Our series are non-stationary in order to make series stationary we apply first difference rule.

First Difference Procedure

Date: 05/01/22 Time: 14:51
Sample: 2010M01 2022M02
Included observations: 144

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.747	-0.747	81.980	0.000
		2	0.359	-0.450	101.01	0.000
		3	-0.172	-0.340	105.44	0.000
		4	0.098	-0.242	106.89	0.000
		5	-0.090	-0.296	108.11	0.000
		6	0.108	-0.206	109.88	0.000
		7	-0.094	-0.170	111.24	0.000
		8	0.058	-0.165	111.76	0.000
		9	-0.045	-0.212	112.07	0.000
		10	0.101	0.031	113.69	0.000
		11	-0.204	-0.175	120.28	0.000
		12	0.289	0.058	133.55	0.000
		13	-0.302	0.011	148.17	0.000
		14	0.207	-0.106	155.10	0.000
		15	-0.060	0.042	155.68	0.000
		16	-0.035	-0.022	155.89	0.000
		17	0.040	-0.048	156.15	0.000
		18	-0.001	-0.042	156.15	0.000
		19	0.008	0.104	156.16	0.000
		20	-0.116	-0.234	158.44	0.000
		21	0.268	0.120	170.71	0.000
		22	-0.359	-0.174	192.92	0.000
		23	0.371	0.157	216.81	0.000
		24	-0.318	-0.038	234.56	0.000
		25	0.219	0.046	243.00	0.000
		26	-0.118	0.114	245.48	0.000
		27	0.051	-0.015	245.95	0.000
		28	-0.032	0.066	246.14	0.000
		29	0.053	0.072	246.64	0.000
		30	-0.092	-0.023	248.22	0.000
		31	0.135	0.033	251.62	0.000
		32	-0.175	0.042	257.35	0.000
		33	0.241	0.070	268.33	0.000
		34	-0.358	-0.099	292.79	0.000
		35	0.439	-0.021	329.96	0.000
		36	-0.390	0.024	359.62	0.000

Date: 05/01/22 Time: 14:52
Sample: 2010M01 2022M02
Included observations: 145

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.624	-0.624	57.579	0.000
		2	0.174	-0.352	62.081	0.000
		3	-0.041	-0.213	62.331	0.000
		4	0.026	-0.102	62.431	0.000
		5	-0.045	-0.109	62.739	0.000
		6	0.004	-0.141	62.742	0.000
		7	0.056	-0.031	63.232	0.000
		8	-0.074	-0.059	64.089	0.000
		9	0.032	-0.077	64.251	0.000
		10	0.015	-0.030	64.285	0.000
		11	-0.043	-0.072	64.584	0.000
		12	0.049	-0.024	64.973	0.000
		13	-0.102	-0.168	66.651	0.000
		14	0.108	-0.121	68.548	0.000
		15	0.010	0.058	68.563	0.000
		16	-0.036	0.089	68.773	0.000
		17	-0.035	-0.030	68.978	0.000
		18	0.034	-0.076	69.175	0.000
		19	0.030	0.023	69.330	0.000
		20	-0.071	-0.001	70.187	0.000
		21	0.081	0.037	71.326	0.000
		22	-0.118	-0.131	73.748	0.000
		23	0.184	0.103	79.640	0.000
		24	-0.280	-0.199	93.407	0.000
		25	0.322	0.051	111.80	0.000
		26	-0.235	-0.015	121.72	0.000
		27	0.045	-0.132	122.09	0.000
		28	0.087	0.019	123.48	0.000
		29	-0.012	0.124	123.50	0.000
		30	-0.120	-0.120	126.16	0.000
		31	0.127	-0.008	129.19	0.000
		32	-0.063	-0.017	129.93	0.000
		33	0.060	0.096	130.62	0.000
		34	-0.124	-0.093	133.58	0.000
		35	0.221	0.122	143.08	0.000
		36	-0.233	0.048	153.74	0.000

Date: 05/01/22 Time: 14:52
Sample: 2010M01 2022M02
Included observations: 144

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.718	-0.718	75.882	0.000
		2	0.267	-0.516	86.411	0.000
		3	-0.028	-0.303	86.524	0.000
		4	-0.110	-0.424	88.348	0.000
		5	0.210	-0.215	95.046	0.000
		6	-0.209	-0.181	101.68	0.000
		7	0.133	-0.133	104.40	0.000
		8	-0.080	-0.192	105.39	0.000
		9	0.054	-0.154	105.84	0.000
		10	-0.029	-0.208	105.97	0.000
		11	0.030	-0.120	106.11	0.000
		12	-0.011	0.015	106.13	0.000
		13	-0.076	-0.134	107.06	0.000
		14	0.132	-0.161	109.86	0.000
		15	-0.086	-0.091	111.06	0.000
		16	0.028	-0.067	111.19	0.000
		17	-0.035	-0.180	111.39	0.000
		18	0.052	-0.139	111.85	0.000
		19	-0.011	-0.053	111.87	0.000
		20	-0.058	-0.162	112.44	0.000
		21	0.114	-0.030	114.65	0.000
		22	-0.184	-0.267	120.47	0.000
		23	0.292	0.090	135.33	0.000
		24	-0.354	-0.024	157.25	0.000
		25	0.267	-0.072	169.84	0.000
		26	-0.075	0.054	170.84	0.000
		27	-0.115	-0.054	173.24	0.000
		28	0.236	0.019	183.34	0.000
		29	-0.272	-0.069	196.84	0.000
		30	0.224	-0.114	206.09	0.000
		31	-0.100	0.035	207.95	0.000
		32	-0.024	0.030	208.06	0.000
		33	0.095	0.109	209.77	0.000
		34	-0.164	-0.122	214.90	0.000
		35	0.219	0.023	224.16	0.000
		36	-0.195	0.031	231.54	0.000

After applying to first difference procedure series are still non-stationary in 5% significancy level. So, we reject the null hypothesis. After that I checked the second order difference procedure still series are non-stationary.

Dickey-Fuller Unit Root Test

H_0: $Series\ is\ non\ stationary\ (It\ icludes\ unit\ root)$

H_1: $Series\ is\ stationary\ (It\ does\ not\ include\ a\ unit\ root)$

Null Hypothesis: LN_TOTAL_SA has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.769188	0.3945
Test critical values:	1% level	-3.476143	
	5% level	-2.881541	
	10% level	-2.577514	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_TOTAL_SA)
Method: Least Squares
Date: 05/01/22 Time: 15:29
Sample (adjusted): 2010M03 2022M02
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_TOTAL_SA(-1)	-0.056268	0.031805	-1.769188	0.0790
D(LN_TOTAL_SA(-1))	-0.551202	0.069709	-7.907187	0.0000
C	0.267531	0.146290	1.828776	0.0695

R-squared	0.345773	Mean dependent var	0.005756
Adjusted R-squared	0.336493	S.D. dependent var	0.086535
S.E. of regression	0.070488	Akaike info criterion	-2.446136
Sum squared resid	0.700566	Schwarz criterion	-2.384265
Log likelihood	179.1218	Hannan-Quinn criter.	-2.420996
F-statistic	37.26071	Durbin-Watson stat	2.187521
Prob(F-statistic)	0.000000		

Null Hypothesis: LN_HIGHTECH_SA has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.731578	0.8343
Test critical values:	1% level	-3.476805	
	5% level	-2.881830	
	10% level	-2.577668	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_HIGHTECH_SA)
Method: Least Squares
Date: 05/01/22 Time: 15:35
Sample (adjusted): 2010M05 2022M02
Included observations: 142 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_HIGHTECH_SA(-1)	-0.020773	0.028395	-0.731578	0.4657
D(LN_HIGHTECH_SA(-1))	-0.934432	0.086886	-10.75467	0.0000
D(LN_HIGHTECH_SA(-2))	-0.564429	0.107395	-5.255614	0.0000
D(LN_HIGHTECH_SA(-3))	-0.226581	0.084122	-2.693465	0.0080
C	0.119339	0.130880	0.911821	0.3635

R-squared	0.507822	Mean dependent var	0.008468
Adjusted R-squared	0.493452	S.D. dependent var	0.175483
S.E. of regression	0.124895	Akaike info criterion	-1.288107
Sum squared resid	2.137038	Schwarz criterion	-1.184028
Log likelihood	96.45558	Hannan-Quinn criter.	-1.245814
F-statistic	35.33862	Durbin-Watson stat	2.034841
Prob(F-statistic)	0.000000		

Null Hypothesis: LN_COMPUTER_SA has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.362231	0.9112
Test critical values:	1% level	-3.477144	
	5% level	-2.881978	
	10% level	-2.577747	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_COMPUTER_SA)
Method: Least Squares
Date: 05/01/22 Time: 15:36
Sample (adjusted): 2010M06 2022M02
Included observations: 141 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_COMPUTER_SA(-1)	-0.013246	0.036569	-0.362231	0.7177
D(LN_COMPUTER_SA(-1))	-0.790631	0.088619	-8.921714	0.0000
D(LN_COMPUTER_SA(-2))	-0.481212	0.106247	-4.529192	0.0000
D(LN_COMPUTER_SA(-3))	-0.341887	0.105568	-3.238561	0.0015
D(LN_COMPUTER_SA(-4))	-0.248868	0.084085	-2.959715	0.0036
C	0.088690	0.169909	0.521983	0.6025

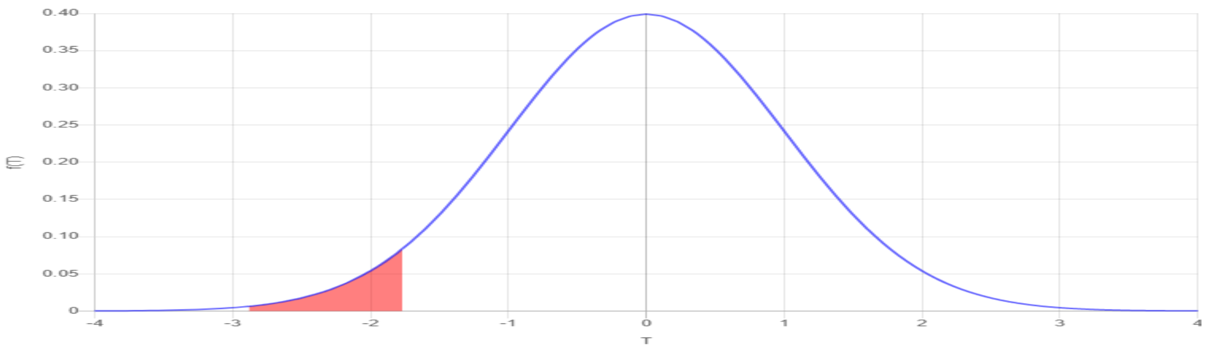
R-squared	0.425141	Mean dependent var	0.008894
Adjusted R-squared	0.403850	S.D. dependent var	0.209016
S.E. of regression	0.161383	Akaike info criterion	-0.768456
Sum squared resid	3.515989	Schwarz criterion	-0.642976
Log likelihood	60.17611	Hannan-Quinn criter.	-0.717465
F-statistic	19.96807	Durbin-Watson stat	1.972807
Prob(F-statistic)	0.000000		

For 5% significancy level for ln_total_sa probability values are greater than 0.05 so we cannot reject the null hypothesis that series has a unit root.

For 5% significancy level for ln_hightech_sa probability values are greater than 0.05 so we cannot reject the null hypothesis that series has a unit root.

For 5% significancy level for ln_computer_sa probability values are greater than 0.05 so we cannot reject the null hypothesis that series has a unit root.

Total Production



For 5% significancy level since the calculated value is doesn’t fall in rejection area, we accept $H_0: Series\ is\ non\ stationary\ (It\ icludes\ unit\ root)$.

Dickey-Fuller Test with Trend and Intercept

Null Hypothesis: LN_TOTAL_SA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.996470	0.0004
Test critical values:	1% level	-4.023042	
	5% level	-3.441330	
	10% level	-3.145211	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_TOTAL_SA)
Method: Least Squares
Date: 05/01/22 Time: 16:12
Sample (adjusted): 2010M03 2022M02
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_TOTAL_SA(-1)	-0.451596	0.090383	-4.996470	0.0000
D(LN_TOTAL_SA(-1))	-0.356430	0.077539	-4.596757	0.0000
C	1.947602	0.387655	5.024061	0.0000
@TREND("2010M01")	0.001860	0.000402	4.631503	0.0000

R-squared	0.432695	Mean dependent var	0.005756
Adjusted R-squared	0.420539	S.D. dependent var	0.086535
S.E. of regression	0.065873	Akaike info criterion	-2.574806
Sum squared resid	0.607487	Schwarz criterion	-2.492311
Log likelihood	189.3860	Hannan-Quinn criter.	-2.541284
F-statistic	35.59364	Durbin-Watson stat	2.040073
Prob(F-statistic)	0.000000		

Probability level is smaller than 0.05 for 5% significancy level we reject the null hypothesis and conclude that series is stationary.

Null Hypothesis: LN_HIGHTECH_SA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.600840	0.0000
Test critical values:	1% level	-4.023042	
	5% level	-3.441330	
	10% level	-3.145211	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_HIGHTECH_SA)
Method: Least Squares
Date: 05/01/22 Time: 16:18
Sample (adjusted): 2010M03 2022M02
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_HIGHTECH_SA(-1)	-0.770435	0.116718	-6.600840	0.0000
D(LN_HIGHTECH_SA(-1))	-0.240083	0.081870	-2.932476	0.0039
C	3.058378	0.460608	6.639878	0.0000
@TREND("2010M01")	0.006750	0.001064	6.341814	0.0000

R-squared	0.534840	Mean dependent var	0.008597
Adjusted R-squared	0.524872	S.D. dependent var	0.175970
S.E. of regression	0.121295	Akaike info criterion	-1.353799
Sum squared resid	2.059744	Schwarz criterion	-1.271304
Log likelihood	101.4735	Hannan-Quinn criter.	-1.320278
F-statistic	53.65727	Durbin-Watson stat	2.046753
Prob(F-statistic)	0.000000		

Null Hypothesis: LN_COMPUTER_SA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.84586	0.0000
Test critical values:	1% level	-4.022586	
	5% level	-3.441111	
	10% level	-3.145082	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_COMPUTER_SA)
Method: Least Squares
Date: 05/01/22 Time: 16:19
Sample (adjusted): 2010M02 2022M02
Included observations: 145 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_COMPUTER_SA(-1)	-0.996533	0.084125	-11.84586	0.0000
C	3.966544	0.335113	11.83645	0.0000
@TREND("2010M01")	0.009063	0.000817	11.09833	0.0000

R-squared	0.497055	Mean dependent var	0.009989
Adjusted R-squared	0.489971	S.D. dependent var	0.206654
S.E. of regression	0.147584	Akaike info criterion	-0.968361
Sum squared resid	3.092923	Schwarz criterion	-0.906773
Log likelihood	73.20616	Hannan-Quinn criter.	-0.943336
F-statistic	70.16854	Durbin-Watson stat	1.996051
Prob(F-statistic)	0.000000		

The independent variables with Dickey-Fuller test with trend and intercept for both probability level is smaller than 0.05 for 5% significancy level we reject the null hypothesis and conclude that series are stationary.

Augmented Dickey-Fuller Test with First Difference (Intercept)

Null Hypothesis: LN_TOTAL_SA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.996470	0.0004
Test critical values:	1% level	-4.023042	
	5% level	-3.441330	
	10% level	-3.145211	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_TOTAL_SA)
Method: Least Squares
Date: 05/01/22 Time: 16:12
Sample (adjusted): 2010M03 2022M02
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_TOTAL_SA(-1)	-0.451596	0.090383	-4.996470	0.0000
D(LN_TOTAL_SA(-1))	-0.356430	0.077539	-4.596757	0.0000
C	1.947602	0.387655	5.024061	0.0000
@TREND("2010M01")	0.001860	0.000402	4.631503	0.0000

R-squared	0.432695	Mean dependent var	0.005756
Adjusted R-squared	0.420539	S.D. dependent var	0.086535
S.E. of regression	0.065873	Akaike info criterion	-2.574806
Sum squared resid	0.607487	Schwarz criterion	-2.492311
Log likelihood	189.3860	Hannan-Quinn criter.	-2.541284
F-statistic	35.59364	Durbin-Watson stat	2.040073
Prob(F-statistic)	0.000000		

Null Hypothesis: LN_COMPUTER_SA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.84586	0.0000
Test critical values:	1% level	-4.022586	
	5% level	-3.441111	
	10% level	-3.145082	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_COMPUTER_SA)
Method: Least Squares
Date: 05/01/22 Time: 16:19
Sample (adjusted): 2010M02 2022M02
Included observations: 145 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_COMPUTER_SA(-1)	-0.996533	0.084125	-11.84586	0.0000
C	3.966544	0.335113	11.83645	0.0000
@TREND("2010M01")	0.009063	0.000817	11.09833	0.0000

R-squared	0.497055	Mean dependent var	0.009989
Adjusted R-squared	0.489971	S.D. dependent var	0.206654
S.E. of regression	0.147584	Akaike info criterion	-0.968361
Sum squared resid	3.092923	Schwarz criterion	-0.906773
Log likelihood	73.20616	Hannan-Quinn criter.	-0.943336
F-statistic	70.16854	Durbin-Watson stat	1.996051
Prob(F-statistic)	0.000000		

Null Hypothesis: LN_HIGHTECH_SA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.600840	0.0000
Test critical values:	1% level	-4.023042	
	5% level	-3.441330	
	10% level	-3.145211	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_HIGHTECH_SA)
Method: Least Squares
Date: 05/01/22 Time: 16:18
Sample (adjusted): 2010M03 2022M02
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_HIGHTECH_SA(-1)	-0.770435	0.116718	-6.600840	0.0000
D(LN_HIGHTECH_SA(-1))	-0.240083	0.081870	-2.932476	0.0039
C	3.058378	0.460608	6.639878	0.0000
@TREND("2010M01")	0.006750	0.001064	6.341814	0.0000

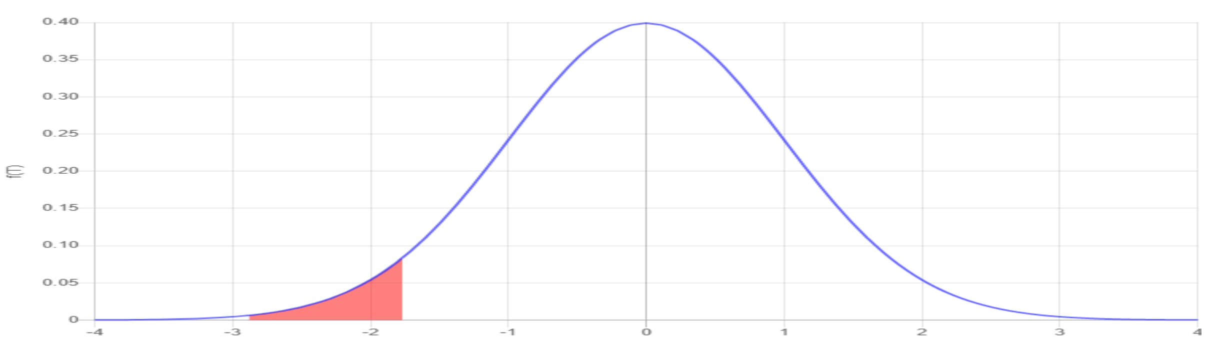
R-squared	0.534840	Mean dependent var	0.008597
Adjusted R-squared	0.524872	S.D. dependent var	0.175970
S.E. of regression	0.121295	Akaike info criterion	-1.353799
Sum squared resid	2.059744	Schwarz criterion	-1.271304
Log likelihood	101.4735	Hannan-Quinn criter.	-1.320278
F-statistic	53.65727	Durbin-Watson stat	2.046753
Prob(F-statistic)	0.000000		

For 5% significancy level for ln_total_sa probability values are smaller than 0.05 so we can reject the null hypothesis that series has a unit root.

For 5% significancy level for ln_hightech_sa probability values are smaller than 0.05 so we can reject the null hypothesis that series has a unit root.

For 5% significancy level for ln_computer_sa probability values are smaller than 0.05 so we can reject the null hypothesis that series has a unit root.

To conclude, we can say that our series are stationary with the Dickey-Fuller test with first difference(Intercept)



For 5% significancy level since the calculated value is falls in rejection area, we reject the null hypothesis. (LN_TOTAL_SA)

5%	LN_TOTAL_SA	
ADF	**Level**	**First Difference**
Constant	**0.3495**	**0.000***
Constant + Trend	**0.0004***	**0.000***
None	**0.9766**	**0.000***
Result		**I(1)**
PP	**Level**	**First Difference**
Constant	**0.1847**	**0.0001***
Constant + Trend	**0.0000***	**0.0001***
None	**0.9990**	**0.0000***
Result		**I(1)**
KPSS	**Level**	**First Difference**
Constant	**1.492988*(Nonsta.)**	**0.139(Stationary)**
Constant + Trend	**0.17397 (Stationary)**	**0.1337(Stationary)**
Result		**I(1)**

As we can see on the summary table for Augmented Dickey-Fuller Phillips-Peron and KPSS test for LN_TOTAL_SA it can be seen that when we check for unit root with constant and trend series become stationary for all test and when we apply the first order difference process series become I(1).

5%	LN_HIGHTECH_SA	
ADF	**Level**	**First Difference**
Constant	**0.8343**	**0.000***
Constant + Trend	**0.0000***	**0.000***
None	**0.9928**	**0.000***
Result		**I(1)**
PP	**Level**	**First Difference**
Constant	**0.1897**	**0.0001***
Constant + Trend	**0.0000***	**0.0001***
None	**0.9961**	**0.0000***
Result		**I(1)**
KPSS	**Level**	**First Difference**
Constant	**1.419(non-stationary)**	**0.19(stationary)**
Constant + Trend	**0.173(non-stationary)**	**0.0779(stationary)**
Result		**I(1)**

As we can see on the summary table for Augmented Dickey-Fuller Phillips-Peron and KPSS test for LN_HIGHTECG_SA it can be seen that when we check for unit root with constant and trend series become stationary for all test and when we apply the first order difference process series become I(1).

5%	LN_COMPUTER_SA	
ADF	**Level**	**First Difference**
Constant	**0.9112**	**0.000***
Constant + Trend	**0.0000***	**0.000***
None	**0.9874**	**0.000***
Result		**I(1)**
PP	**Level**	**First Difference**
Constant	**0.1776**	**0.0001***
Constant + Trend	**0.0000***	**0.0001***
None	**0.9983**	**0.0000***
Result		**I(1)**
KPSS	**Level**	**First Difference**
Constant	**1.55 (non-stationary)**	**0.127(stationary)**
Constant + Trend	**0.046(stationary)**	**0.115(stationary)**
Result		**I(1)**

As we can see on the summary table for Augmented Dickey-Fuller Phillips-Peron and KPSS test for LN_COMPUTER_SA it can be seen that when we check for unit root with constant and trend series become stationary for all test and when we apply the first order difference process series become I(1).

VAR Analysis

Vector Autoregression Estimates
Date: 05/01/22 Time: 18:01
Sample (adjusted): 2010M04 2022M02
Included observations: 143 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DLN_COMPU	DLN_HIGHT	DLN_TOTAL_
DLN_COMPUTER_SA(-1)	-0.570442	-0.029735	0.027726
	(0.10341)	(0.08022)	(0.04418)
	[-5.51605]	[-0.37069]	[0.62751]
DLN_COMPUTER_SA(-2)	-0.281279	0.128757	0.062844
	(0.10356)	(0.08033)	(0.04425)
	[-2.71618]	[1.60294]	[1.42035]
DLN_HIGHTECH_SA(-1)	-0.242588	-0.834293	-0.093412
	(0.14065)	(0.10910)	(0.06009)
	[-1.72473]	[-7.64708]	[-1.55441]
DLN_HIGHTECH_SA(-2)	0.115150	-0.457110	-0.079997
	(0.14476)	(0.11229)	(0.06185)
	[0.79544]	[-4.07092]	[-1.29340]
DLN_TOTAL_SA(-1)	-0.027399	-0.001729	-0.606320
	(0.25254)	(0.19589)	(0.10790)
	[-0.10849]	[-0.00883]	[-5.61926]
DLN_TOTAL_SA(-2)	-0.378853	-0.079336	-0.172053
	(0.25338)	(0.19654)	(0.10826)
	[-1.49517]	[-0.40366]	[-1.58926]
C	0.022378	0.019141	0.010539
	(0.01388)	(0.01077)	(0.00593)
	[1.61182]	[1.77742]	[1.77671]
R-squared	0.404715	0.497658	0.375712
Adj. R-squared	0.378453	0.475496	0.348170
Sum sq. resids	3.657747	2.200704	0.667713
S.E. equation	0.163998	0.127207	0.070069
F-statistic	15.41034	22.45534	13.64136
Log likelihood	59.21060	95.53761	180.8138
Akaike AIC	-0.730218	-1.238288	-2.430963
Schwarz SC	-0.585184	-1.093254	-2.285929
Mean dependent	0.010437	0.007084	0.005508
S.D. dependent	0.208018	0.175645	0.086788

Determinant resid covariance (dof adj.)	7.55E-07
Determinant resid covariance	6.50E-07
Log likelihood	409.9360
Akaike information criterion	-5.439665
Schwarz criterion	-5.004561
Number of coefficients	21

Since the data's frequency is monthly, I chose lag length criteria as 24.

VAR Lag Order Selection Criteria
Endogenous variables: DLN_COMPUTER_SA DLN_HIGHTECH_SA DLN_TOTAL_SA
Exogenous variables: C
Date: 05/01/22 Time: 18:03
Sample: 2010M01 2022M02
Included observations: 121

Lag	LogL	LR	FPE	AIC	SC	HQ
0	261.2571	NA	2.81e-06	-4.268713	-4.199396	-4.240561
1	321.6424	116.7780	1.20e-06	-5.118055	-4.840787	-5.005446
2	345.5976	45.13873	9.39e-07	-5.365249	-4.880029*	-5.168183*
3	358.3669	23.42809	8.83e-07*	-5.427552	-4.734381	-5.146029
4	364.3864	10.74557	9.29e-07	-5.378288	-4.477165	-5.012308
5	371.1893	11.80667	9.65e-07	-5.341972	-4.232898	-4.891535
6	377.8282	11.19279	1.01e-06	-5.302945	-3.985920	-4.768051
7	385.6962	12.87498	1.03e-06	-5.284235	-3.759258	-4.664884
8	389.5365	6.093734	1.13e-06	-5.198951	-3.466023	-4.495143
9	396.0149	9.958471	1.19e-06	-5.157271	-3.216392	-4.369006
10	402.5092	9.660863	1.25e-06	-5.115854	-2.967023	-4.243132
11	416.0286	19.44116	1.17e-06	-5.190555	-2.833773	-4.233376
12	430.9307	20.69055*	1.08e-06	-5.288111	-2.723377	-4.246475
13	439.3714	11.30080	1.11e-06	-5.278867	-2.506182	-4.152774
14	448.8258	12.18917	1.12e-06	-5.286378	-2.305741	-4.075828
15	451.8898	3.798319	1.26e-06	-5.188262	-1.999674	-3.893255
16	460.0139	9.668303	1.32e-06	-5.173783	-1.777244	-3.794319
17	464.7037	5.348742	1.46e-06	-5.102541	-1.498051	-3.638620
18	470.6035	6.436135	1.59e-06	-5.051298	-1.238856	-3.502920
19	481.3458	11.18619	1.61e-06	-5.080096	-1.059703	-3.447261
20	490.7230	9.299671	1.68e-06	-5.086330	-0.857986	-3.369038
21	504.0210	12.52875	1.65e-06	-5.157372	-0.721077	-3.355624
22	514.1709	9.059411	1.73e-06	-5.176379	-0.532132	-3.290173
23	529.5707	12.98163	1.67e-06	-5.282160	-0.429962	-3.311498
24	548.0409	14.65403	1.54e-06	-5.438692*	-0.378542	-3.383572

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

We can detect that for Hannah-Quin information criterion and Schwarz information criterion on the second lag is selected.

System: UNTITLED
Estimation Method: Least Squares
Date: 05/02/22 Time: 15:46
Sample: 2010M04 2022M02
Included observations: 143
Total system (balanced) observations 429

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.109489	0.061185	-1.789484	0.0743
C(2)	-0.549990	0.111570	-4.929559	0.0000
C(3)	-0.157476	0.107702	-1.462143	0.1445
C(4)	-0.045181	0.065424	-0.690597	0.4902
C(5)	-0.050636	0.063512	-0.797266	0.4258
C(6)	-0.052888	0.062853	-0.841445	0.4006
C(7)	0.019059	0.050251	0.379285	0.7047
C(8)	0.010675	0.005885	1.813933	0.0704
C(9)	-0.051105	0.112302	-0.455065	0.6493
C(10)	0.024563	0.204781	0.119947	0.9046
C(11)	-0.072532	0.197683	-0.366911	0.7139
C(12)	-0.811781	0.120082	-6.760208	0.0000
C(13)	-0.443405	0.116573	-3.803684	0.0002
C(14)	-0.067362	0.115365	-0.583906	0.5596
C(15)	0.108320	0.092233	1.174419	0.2409
C(16)	0.019204	0.010801	1.777943	0.0762
C(17)	0.316124	0.142315	2.221303	0.0269
C(18)	-0.190038	0.259510	-0.732296	0.4644
C(19)	-0.420940	0.250514	-1.680303	0.0937
C(20)	-0.381843	0.152175	-2.509238	0.0125
C(21)	0.030376	0.147727	0.205620	0.8372
C(22)	-0.337687	0.146197	-2.309816	0.0214
C(23)	-0.154861	0.116882	-1.324933	0.1859
C(24)	0.021986	0.013688	1.606231	0.1090

Determinant residual covariance 5.62E-07

Equation: D(LN_TOTAL_SA) = C(1)*(LN_TOTAL_SA(-1) + 0.678771983088 *LN_HIGHTECH_SA(-1) - 1.12371519707*LN_COMPUTER_SA(-1) - 2.50903444962) + C(2)*D(LN_TOTAL_SA(-1)) + C(3) *D(LN_TOTAL_SA(-2)) + C(4)*D(LN_HIGHTECH_SA(-1)) + C(5) *D(LN_HIGHTECH_SA(-2)) + C(6)*D(LN_COMPUTER_SA(-1)) + C(7) *D(LN_COMPUTER_SA(-2)) + C(8)

Observations: 143

R-squared	0.390177	Mean dependent var	0.005508
Adjusted R-squared	0.358557	S.D. dependent var	0.086788
S.E. of regression	0.069508	Sum squared resid	0.652241
Durbin-Watson stat	2.072162		

Equation: D(LN_HIGHTECH_SA) = C(9)*(LN_TOTAL_SA(-1) + 0.678771983088*LN_HIGHTECH_SA(-1) - 1.12371519707 *LN_COMPUTER_SA(-1) - 2.50903444962) + C(10) *D(LN_TOTAL_SA(-1)) + C(11)*D(LN_TOTAL_SA(-2)) + C(12) *D(LN_HIGHTECH_SA(-1)) + C(13)*D(LN_HIGHTECH_SA(-2)) + C(14) *D(LN_COMPUTER_SA(-1)) + C(15)*D(LN_COMPUTER_SA(-2)) + C(16)

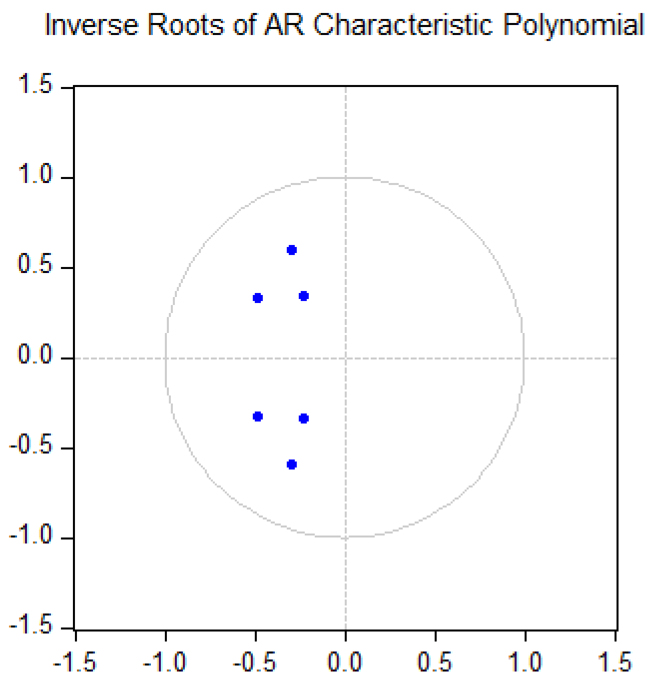
Observations: 143

R-squared	0.498428	Mean dependent var	0.007084
Adjusted R-squared	0.472420	S.D. dependent var	0.175645
S.E. of regression	0.127580	Sum squared resid	2.197333
Durbin-Watson stat	2.194141		

Equation: D(LN_COMPUTER_SA) = C(17)*(LN_TOTAL_SA(-1) + 0.678771983088*LN_HIGHTECH_SA(-1) - 1.12371519707 *LN_COMPUTER_SA(-1) - 2.50903444962) + C(18) *D(LN_TOTAL_SA(-1)) + C(19)*D(LN_TOTAL_SA(-2)) + C(20) *D(LN_HIGHTECH_SA(-1)) + C(21)*D(LN_HIGHTECH_SA(-2)) + C(22) *D(LN_COMPUTER_SA(-1)) + C(23)*D(LN_COMPUTER_SA(-2)) + C(24)

Observations: 143

R-squared	0.425705	Mean dependent var	0.010437
Adjusted R-squared	0.395927	S.D. dependent var	0.208018
S.E. of regression	0.161676	Sum squared resid	3.528772
Durbin-Watson stat	2.055783		



Since are inverse roots are taking place withing the unit circle. Our VAR system is stable we can use this data.

Autocorrelation LM Test

VAR Residual Serial Correlation LM Tests
Date: 05/01/22 Time: 18:15
Sample: 2010M01 2022M02
Included observations: 143

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	25.49367	9	0.0025	2.915617	(9, 319.0)	0.0025
2	18.45283	9	0.0303	2.087209	(9, 319.0)	0.0303
3	28.16886	9	0.0009	3.235146	(9, 319.0)	0.0009
4	8.184262	9	0.5157	0.911004	(9, 319.0)	0.5157
5	8.419099	9	0.4925	0.937487	(9, 319.0)	0.4926
6	7.285282	9	0.6074	0.809803	(9, 319.0)	0.6075
7	16.33552	9	0.0602	1.841610	(9, 319.0)	0.0602
8	14.12899	9	0.1178	1.587370	(9, 319.0)	0.1178
9	3.738652	9	0.9278	0.413288	(9, 319.0)	0.9278
10	20.51452	9	0.0150	2.327914	(9, 319.0)	0.0150
11	12.88339	9	0.1680	1.444616	(9, 319.0)	0.1680
12	19.73901	9	0.0196	2.237191	(9, 319.0)	0.0196

$H_0: No\ serial\ correlation\ at\ lags\ 1\ to\ h$

$H_A: Serial\ Correlation\ exists\ at\ lags\ 1\ to\ h$

Until the fourth lag we can easily detect that we have a autocorrelation problem and tenth and twelfth lag on the other hand we can focus on other lags without the autocorrelation problem.

Cointegration Tests

Engle Granger Test

Null Hypothesis: RESID01 has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.541965	0.0000
Test critical values:	1% level	-2.581120	
	5% level	-1.943058	
	10% level	-1.615241	

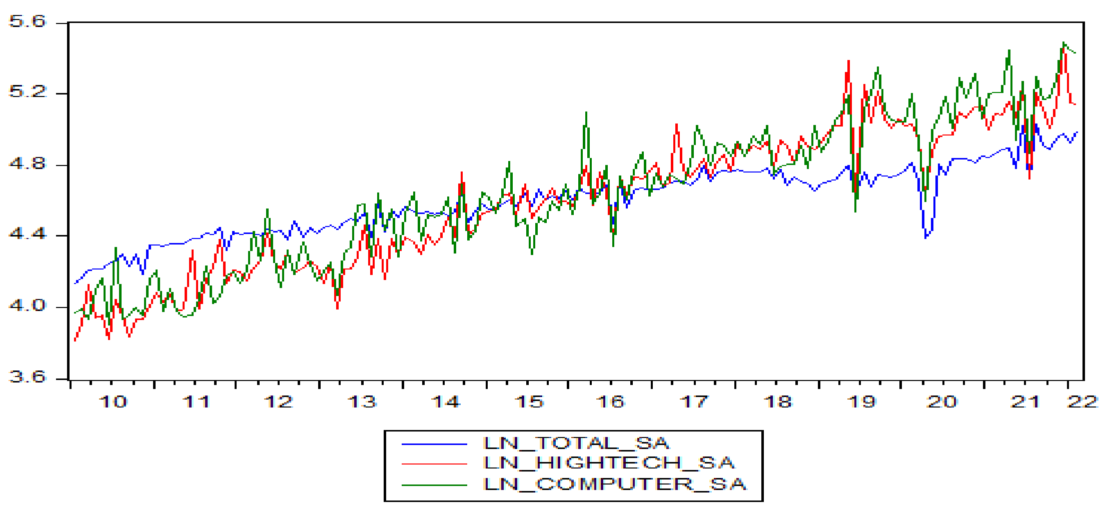
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID01)
Method: Least Squares
Date: 05/01/22 Time: 19:08
Sample (adjusted): 2010M03 2022M02
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.382303	0.084171	-4.541965	0.0000
D(RESID01(-1))	-0.367566	0.077557	-4.739320	0.0000

R-squared	0.393274	Mean dependent var	0.001573
Adjusted R-squared	0.389001	S.D. dependent var	0.069098
S.E. of regression	0.054011	Akaike info criterion	-2.985450
Sum squared resid	0.414247	Schwarz criterion	-2.944203
Log likelihood	216.9524	Hannan-Quinn criter.	-2.968690
Durbin-Watson stat	1.992323		

I applied Dicky-Fuller unit root test with none option for 5% significancy level our t-statistic value is falling in rejection area and the probability value is smaller than 0.05 so it is significant we are rejecting null hypothesis that residual has a unit root. So, residuals are stationary total production, high technology and computer components productions are cointegrated which means they have a long run relationship among them they move together.



Johansen Cointegration Test

In Johansen Cointegration test we check the probability values at None* and At most 1* we can easily spot that our probability value is smaller than 0.05 for 5% significancy level we reject the null hypothesis, on the other hand At most 2 our probability value is 0.3285 which is grater than 0.05 so we accept the null hypothesis.

Unrestricted Cointegration Rank Test(Maximum Eigen Value)

We reject null hypothesis at most 1* with probability value of 0.0127 in other two cases None and At most 2 we reject the null hypothesis.

Normalized Vector

Normalized cointegrating coefficients (standard error in parentheses)

LN_TOTAL_SA	LN_HIGHTECH_SA	LN_COMPUTER_SA
1.000000	0.678772	-1.123715
	(0.25588)	(0.24973)

Adjustment coefficients (standard error in parentheses)

D(LN_TOTAL_SA)	-0.109489
	(0.06118)
D(LN_HIGHTECH_SA)	-0.051105
	(0.11230)
D(LN_COMPUTER_SA)	0.316124
	(0.14231)

LN_TOTAL_SA +0.678772 – 1.123715 = 0

LN_TOTAL_SA = -0.678772+1.123715

Under the ceteris paribus conditions when 1% increase in Total production on average 0.68% decrease on high technology production and 1.12% increase in computer parts production. Total production and Computer production parts are positively related but high technology products are negatively.

Date: 05/02/22 Time: 00:38
Sample (adjusted): 2010M04 2022M02
Included observations: 143 after adjustments
Trend assumption: Linear deterministic trend
Series: LN_TOTAL_SA LN_HIGHTECH_SA LN_COMPUTER_SA
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.134915	39.58534	29.79707	0.0027
At most 1 *	0.117695	18.86077	15.49471	0.0149
At most 2	0.006654	0.954692	3.841466	0.3285

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.134915	20.72457	21.13162	0.0569
At most 1 *	0.117695	17.90608	14.26460	0.0127
At most 2	0.006654	0.954692	3.841466	0.3285

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LN_TOTAL_SA	LN_HIGHTEC	LN_COMPUTER_SA
10.52622	7.144905	-11.82848
17.01571	-11.70312	3.739985
0.493255	-1.912590	-0.993586

Unrestricted Adjustment Coefficients (alpha):

D(LN_TOTAL_	-0.010402	-0.009980	0.004484
D(LN_HIGHTE	-0.004855	0.018109	0.009094
D(LN_COMPU	0.030032	-0.006761	0.011096

1 Cointegrating Equation(s): Log likelihood 420.2983

Normalized cointegrating coefficients (standard error in parentheses)

LN_TOTAL_SA	LN_HIGHTEC	LN_COMPUTER_SA
1.000000	0.678772	-1.123715
	(0.25588)	(0.24973)

Adjustment coefficients (standard error in parentheses)

D(LN_TOTAL_	-0.109489
	(0.06118)
D(LN_HIGHTE	-0.051105
	(0.11230)
D(LN_COMPU	0.316124
	(0.14231)

2 Cointegrating Equation(s): Log likelihood 429.2513

Normalized cointegrating coefficients (standard error in parentheses)

LN_TOTAL_SA	LN_HIGHTEC	LN_COMPUTER_SA
1.000000	0.000000	-0.456389
		(0.03273)
0.000000	1.000000	-0.983137
		(0.04778)

Adjustment coefficients (standard error in parentheses)

D(LN_TOTAL_	-0.279305	0.042479
	(0.11502)	(0.07883)
D(LN_HIGHTE	0.257034	-0.246621
	(0.21117)	(0.14472)
D(LN_COMPU	0.201073	0.293706
	(0.27026)	(0.18521)

ECM

Long Run Equation

Cointegrating Eq:	CointEq1
LN_TOTAL_SA(-1)	1.000000
LN_HIGHTECH_SA(-1)	0.678772 (0.25588) [2.65265]
LN_COMPUTER_SA(-1)	-1.123715 (0.24973) [-4.49968]
C	-2.509034

$$\mathbf{ECT_{t-1} = LN\_TOTAL_{t-1} + 0.679LN\_HIGHTECH_{t-1} - 1.123LN\_COMPUTER_{t-1} - 2.509}$$

Error Correction:	D(LN_TOTAL_SA)	D(LN_HIGHTECH_SA)	D(LN_COMPUTER_SA)
CointEq1	-0.109489 (0.06118) [-1.78948]	-0.051105 (0.11230) [-0.45507]	0.316124 (0.14231) [2.22130]

Speed of Adjustment Coefficient : -0.109489

It is negative and not significant at 10% significancy level.

According to the Johansen Significancy test this error mechanism doesn’t work.Since our error mechanism doesn’t work our cointegration relationship is not significant

System: UNTITLED
Estimation Method: Least Squares
Date: 05/02/22 Time: 15:46
Sample: 2010M04 2022M02
Included observations: 143
Total system (balanced) observations 429

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.109489	0.061185	-1.789484	0.0743
C(2)	-0.549990	0.111570	-4.929559	0.0000
C(3)	-0.157476	0.107702	-1.462143	0.1445
C(4)	-0.045181	0.065424	-0.690597	0.4902
C(5)	-0.050636	0.063512	-0.797266	0.4258
C(6)	-0.052888	0.062853	-0.841445	0.4006
C(7)	0.019059	0.050251	0.379285	0.7047
C(8)	0.010675	0.005885	1.813933	0.0704
C(9)	-0.051105	0.112302	-0.455065	0.6493
C(10)	0.024563	0.204781	0.119947	0.9046
C(11)	-0.072532	0.197683	-0.366911	0.7139
C(12)	-0.811781	0.120082	-6.760208	0.0000
C(13)	-0.443405	0.116573	-3.803684	0.0002
C(14)	-0.067362	0.115365	-0.583906	0.5596
C(15)	0.108320	0.092233	1.174419	0.2409
C(16)	0.019204	0.010801	1.777943	0.0762
C(17)	0.316124	0.142315	2.221303	0.0269
C(18)	-0.190038	0.259510	-0.732296	0.4644
C(19)	-0.420940	0.250514	-1.680303	0.0937
C(20)	-0.381843	0.152175	-2.509238	0.0125
C(21)	0.030376	0.147727	0.205620	0.8372
C(22)	-0.337687	0.146197	-2.309816	0.0214
C(23)	-0.154861	0.116882	-1.324933	0.1859
C(24)	0.021986	0.013688	1.606231	0.1090

Determinant residual covariance 5.62E-07

Equation: D(LN_TOTAL_SA) = C(1)*(LN_TOTAL_SA(-1) + 0.678771983088 *LN_HIGHTECH_SA(-1) - 1.12371519707*LN_COMPUTER_SA(-1) - 2.50903444962) + C(2)*D(LN_TOTAL_SA(-1)) + C(3) *D(LN_TOTAL_SA(-2)) + C(4)*D(LN_HIGHTECH_SA(-1)) + C(5) *D(LN_HIGHTECH_SA(-2)) + C(6)*D(LN_COMPUTER_SA(-1)) + C(7) *D(LN_COMPUTER_SA(-2)) + C(8)

Observations: 143

R-squared	0.390177	Mean dependent var	0.005508
Adjusted R-squared	0.358557	S.D. dependent var	0.086788
S.E. of regression	0.069508	Sum squared resid	0.652241
Durbin-Watson stat	2.072162		

Equation: D(LN_HIGHTECH_SA) = C(9)*(LN_TOTAL_SA(-1) + 0.678771983088*LN_HIGHTECH_SA(-1) - 1.12371519707 *LN_COMPUTER_SA(-1) - 2.50903444962) + C(10) *D(LN_TOTAL_SA(-1)) + C(11)*D(LN_TOTAL_SA(-2)) + C(12) *D(LN_HIGHTECH_SA(-1)) + C(13)*D(LN_HIGHTECH_SA(-2)) + C(14) *D(LN_COMPUTER_SA(-1)) + C(15)*D(LN_COMPUTER_SA(-2)) + C(16)

Observations: 143

R-squared	0.498428	Mean dependent var	0.007084
Adjusted R-squared	0.472420	S.D. dependent var	0.175645
S.E. of regression	0.127580	Sum squared resid	2.197333
Durbin-Watson stat	2.194141		

Equation: D(LN_COMPUTER_SA) = C(17)*(LN_TOTAL_SA(-1) + 0.678771983088*LN_HIGHTECH_SA(-1) - 1.12371519707 *LN_COMPUTER_SA(-1) - 2.50903444962) + C(18) *D(LN_TOTAL_SA(-1)) + C(19)*D(LN_TOTAL_SA(-2)) + C(20) *D(LN_HIGHTECH_SA(-1)) + C(21)*D(LN_HIGHTECH_SA(-2)) + C(22) *D(LN_COMPUTER_SA(-1)) + C(23)*D(LN_COMPUTER_SA(-2)) + C(24)

Observations: 143

R-squared	0.425705	Mean dependent var	0.010437
Adjusted R-squared	0.395927	S.D. dependent var	0.208018
S.E. of regression	0.161676	Sum squared resid	3.528772
Durbin-Watson stat	2.055783		

Granger Causality

H_0: X does not Granger Cause Y and Z

H_A: X Granger Causes Y and Z

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/02/22 Time: 16:09
Sample: 2010M01 2022M02
Included observations: 143

Dependent variable: DLN_TOTAL_SA

Excluded	Chi-sq	df	Prob.
DLN_HIGHTECH_SA	2.785910	2	0.2483
DLN_COMPUTER_SA	2.018787	2	0.3644
All	4.314733	4	0.3651

Dependent variable: DLN_HIGHTECH_SA

Excluded	Chi-sq	df	Prob.
DLN_TOTAL_SA	0.225753	2	0.8933
DLN_COMPUTER_SA	3.881531	2	0.1436
All	3.919348	4	0.4170

Dependent variable: DLN_COMPUTER_SA

Excluded	Chi-sq	df	Prob.
DLN_TOTAL_SA	2.937867	2	0.2302
DLN_HIGHTECH_SA	6.533288	2	0.0381
All	8.374649	4	0.0788

We investigate that whether there is causality running from dependent variable to independent variable. For both 5% and 10% significancy level our probability values are not significant so we accept the null hypothesis that total production is granger causes both high technology good production and computer components production.

Impulse Response

Response of DLN_TOTAL_SA:

Period	DLN_TOTAL	DLN_HIGHT	DLN_COMP
1	0.070069	0.000000	0.000000
2	-0.047060	-0.007666	0.003335
3	0.020067	0.007270	0.003969
4	-0.005416	-0.002241	-0.008754
5	-0.001175	-0.000416	0.005931
6	0.003282	-2.05E-05	-0.000607
7	-0.002726	0.000846	-0.002035
8	0.001223	-0.000612	0.001555
9	-0.000106	-0.000141	-0.000193
10	-0.000247	0.000516	-0.000422

Response of DLN_HIGHTECH_SA:

Period	DLN_TOTAL	DLN_HIGHT	DLN_COMP
1	0.074527	0.103089	0.000000
2	-0.064857	-0.088113	-0.003577
3	0.027701	0.037467	0.020508
4	0.000915	-0.000320	-0.024763
5	-0.013599	-0.010079	0.011499
6	0.013709	0.005154	0.003572
7	-0.007610	0.000435	-0.008524
8	0.001421	-0.001278	0.004833
9	0.001644	-0.000351	5.99E-05
10	-0.001776	0.001237	-0.001808

Response of DLN_COMPUTER_SA:

Period	DLN_TOTAL	DLN_HIGHT	DLN_COMP
1	0.086061	0.070831	0.120298
2	-0.069092	-0.065413	-0.068623
3	0.014265	0.050847	0.006084
4	0.014388	-0.027136	0.009072
5	-0.016706	0.002877	0.000218
6	0.010971	0.009260	-0.005163
7	-0.006096	-0.008344	0.001111
8	0.002647	0.002628	0.003583
9	-1.72E-05	0.000905	-0.003782
10	-0.001430	-0.001081	0.001108

Cholesky Ordering: DLN_TOTAL_SA DLN_HIGHTECH_SA DLN_COMPUTER_SA

When we apply one standard deviation shock to total production series the response of the variable itself will be 0.07 unit in the first period. As we can see responses are becoming lower and lower