```
In [26]:
          import numpy as np
          import pandas as pd
          import xlsxwriter as ExcelWriter
          import statsmodels.tsa.api as smt
          import matplotlib.pyplot as plt
          import matplotlib.dates as mdates
          from matplotlib.dates import DateFormatter
          import seaborn as sns
          import datetime as dt
          from pandas.plotting import register matplotlib converters # Handle date-time
          register matplotlib converters()
                                                                      #conversions between
                                                                      #pandas and matplotlib
          %matplotlib inline
          import linearmodels as plm
          import statsmodels.api as sm
          import statsmodels.formula.api as smf
          import statsmodels.tsa.api as smt
          import statsmodels.stats.outliers influence as smo
          from statsmodels.tsa.api import VAR
          from statsmodels.stats.outliers influence import variance inflation factor
          from statsmodels.graphics.tsaplots import plot pacf
          from statsmodels.graphics.tsaplots import plot acf
          from statsmodels.tsa.arima process import ArmaProcess
          from statsmodels.tsa.stattools import pacf
          from statsmodels.regression.linear model import yule walker
          from statsmodels.tsa.stattools import adfuller
          import matplotlib.pyplot as plt
          import numpy as np
```

```
# Panel Dataset:
Date = Start 2020-03-04, End 2021-12-31
Month = 1 if Jan., 2 if Feb., 3 if Mar., and so forth.
Day = 1 if yyyy-mm-01, 2 if yyyy-mm-02, 3 if yyyy-mm-03, and so forth.
DateWk = String for names of each weekday, Monday thru Sunday
DSP = 1 if Apple Music, 2 if SoundCloud, 3 if Spotify;
Streams = Daily # of streams from associated Digital Streaming
Platform(DSP)
Listeners = Daily # of listeners from associated Digital Streaming
Platform(DSP)
CMEngage = ChartMetric growth in Engagement Ranking
CMCrossP = ChartMetric growth in Cross-Platform Performance
TWFollowers = Daily count of Twitter Followers
TWRetweets = Daily # of Twitter Retweets
IGReach = Daily # of unique accounts reached by Instagrame Story
```

```
In [27]:
          Panel = pd.read csv("/Users"
                                "/andrew7"
                                "/Desktop/"
                                "[TONE DA]/"
                                "Estimation 22/"
                                "Consolidated Data 01 2022"
                                "/Tone Est Paneled II.csv",
                              parse dates = [0])
          Panel
```

	Date	Month	Day	DateWk	Year	DSP	Streams	Listeners	CMEngage	CMCrossP	TWFollowers	ΤV
0	2020- 03- 04	3	4	Wednesday	2020	1	7	7	379454	465864	226	
1	2020- 03- 05	3	5	Thursday	2020	1	58	7	404875	487377	226	
2	2020- 03- 06	3	6	Friday	2020	1	59	8	407748	494572	227	
3	2020- 03-07	3	7	Saturday	2020	1	57	4	413262	498931	227	
4	2020- 03- 08	3	8	Sunday	2020	1	19	5	411552	497810	227	
•••												
1998	2021- 12-27	12	27	Monday	2021	3	5430	4137	131006	160044	381	
1999	2021- 12-28	12	28	Tuesday	2021	3	5917	4513	128797	157601	381	
2000	2021- 12-29	12	29	Wednesday	2021	3	6479	4782	117195	143391	381	
2001	2021- 12-30	12	30	Thursday	2021	3	5854	4571	116277	142352	381	
2002	2021- 12-31	12	31	Friday	2021	3	5476	4283	114926	140372	382	

2003 rows × 13 columns

```
In [28]:
#Panel['lnDiffEGR'] = np.log(Panel['CMEngage'].diff()).bfill().ffill()
#Panel['lnDiffIGR'] = np.log(Panel['IGReach'].diff()).bfill().ffill()
#Panel['lnDiffS'] = np.log(Panel['Streams'].diff()).bfill().ffill()
#Panel['lnDiffL'] = np.log(Panel['Listeners'].diff()).bfill().ffill()
#Panel['lnDiffTWR'] = np.log(Panel['TWRetweets'].diff()).bfill().ffill()
#Panel['lnDiffTWF'] = np.log(Panel['TWFollowers'].diff()).bfill().ffill()
#Panel[['lnDiffIGR','lnDiffEGR','lnDiffS','lnDiffL','lnDiffTWR','lnDiffTWF']]
```

Mapping dicts of strings for the following: Day of the Week; Digital Streaming Platform(DSP)

Out[29]:		Date	Month	Day	DateWk	Year	DSP	Streams	Listeners	CMEngage	CMCrossP	TWFollowers TV
	0	2020- 03- 04	3	4	Wednesday	2020	1	7	7	379454	465864	226
	1	2020- 03- 05	3	5	Thursday	2020	1	58	7	404875	487377	226
	2	2020- 03- 06	3	6	Friday	2020	1	59	8	407748	494572	227
	3	2020- 03-07	3	7	Saturday	2020	1	57	4	413262	498931	227
	4	2020- 03- 08	3	8	Sunday	2020	1	19	5	411552	497810	227
	•••											
1	998	2021- 12-27	12	27	Monday	2021	3	5430	4137	131006	160044	381
1	999	2021- 12-28	12	28	Tuesday	2021	3	5917	4513	128797	157601	381
2	000	2021- 12-29	12	29	Wednesday	2021	3	6479	4782	117195	143391	381
2	2001	2021- 12-30	12	30	Thursday	2021	3	5854	4571	116277	142352	381
2	2002	2021- 12-31	12	31	Friday	2021	3	5476	4283	114926	140372	382

2003 rows × 15 columns

```
# Mapping a new dictionary, "Data":
    Date = yyyy-mm-dd
    Platform = Apple Music(=1), SoundCloud(=2), Spotify(=3)
    DateWk = Day of the week, ie., Monday(=1), Tuesday(=2), and so
forth.

Month = [mm] Jan.(=1), Feb.(=2), Mar(=3), and so forth.
    Year = [yyyy], 2020 - 2021
    S = Streams
    L = Listeners
    TWF = Twitter Followers
    TWR = Twitter Followers
    TWR = Twitter Retweets
    EGR = Engagement Ranking
    CPP = Cross-Platform Performance Ranking
    IGR = Instagram Story 'Reach'
    DSP_str = Apple Music, ..., Spotify (For Indexing)
```

```
'TWF': Panel['TWFollowers'],
            'TWR': Panel['TWRetweets'],
            'EGR': Panel['CMEngage'],
            'CPP': Panel['CMCrossP'],
            'IGR': Panel['IGReach'],
            'DSP str': Panel['DSPstr']}
Data = pd.DataFrame(Data dict)
Data[['S','L','EGR','IGR','TWR','TWF','CPP']].astype(float)
Data.replace([-np.inf, np.inf], np.nan, inplace=True)
Data['IGR'] = Data['IGR'].bfill().ffill()
Data['S'] = Data['S'].bfill().ffill()
Data['TWR'] = Data['TWR'].bfill().ffill()
Data['L'] = Data['L'].bfill().ffill()
Data['TWF'] = Data['TWF'].bfill().ffill()
with pd.option context('display.max rows', None, 'display.max columns', None):
    print(Data[['S','L','EGR','IGR','TWR','TWF','CPP']])
         S
              L
                    EGR
                              IGR TWR TWF
                                               CPP
         7
0
              7 379454 186.250000 0 226 465864
1
        58
               7 404875 168.500000
                                   0 226 487377
2
        59
               8 407748 164.666667
                                  0 227 494572
3
        57
               4 413262 179.000000 0 227 498931
4
        19
              5 411552 180.666667 0 227 497810
5
              11 415817 225.250000 0 227 501227
        38
6
        40
              9 414664 190.000000
                                  0 226 500469
7
         7
              7 414341 180.000000 0 226 500399
8
        10
              7 413918 207.6666667 0 226 500335
9
              7 415214 169.000000 0 227 501318
         8
10
         7
                        0.000000 0 226 500659
              3 413591
11
         7
             5 408760 171.500000 0 226 496706
12
         6
              4 399549
                        0.000000 0 226 484701
              5 399135 193.285714
         5
                                  0 226 484657
13
14
         8
             8 406383 161.666667 0 225 488540
         5
15
             5 417056 148.333333 0 225 494006
16
         2
             2 418699 148.600000 0 225 494503
17
         5
             4 426139 123.000000
                                   0 225 498981
18
         1
             1 429750 0.000000 0 225 501102
19
        2
             2 438659
                        0.000000 0 225 507319
20
        5
              4 445913 160.222222 0 225 511525
21
        28
              20 448515 105.500000 0 225 512635
22
        45
              27 452730 127.000000 0 226 514821
23
        17
             9 341602
                        0.000000 0 225 382407
             11 343616
                        0.000000
                                   0 226 384935
24
        13
25
        15
              10 333774 138.000000 0 226 374229
26
        4
             4 322209 146.000000 0 227 366514
27
             12 312061 178.200000 0 227 362294
        16
28
        13
              9 324869 162.800000
                                    0 227 371120
29
        27
             16 282651 160.600000 0 227 334575
             15 285552 196.571429 0 227 336553
30
        18
             9 290998 165.909091
                                   2 227 341518
31
        17
        20
              13 288818 175.500000 3 227
32
                                           338022
33
        6
             6 283728 203.666667 3 227 332444
34
        10
               8 288997 218.666667
                                    3 228 334539
               9 296078 168.750000
35
                                     3 228 341988
        10
36
         0
              0 299220 177.833333 3 228 345197
37
         6
               6 448821 168.333333 3 227 502606
         7
              4 472256 159.333333 0 228 522166
38
              7 481960 165.000000
39
        12
                                   0 229 530635
40
         6
              4 505548 139.750000 0 227 547701
41
         4
              4 539644
                        0.000000 0 227 572423
              3 547905 165.800000
                                  0 226 578003
42
         3
43
         4
              4 562240 162.000000 0 226 594268
44
         4
             3 555210 142.666667 0 225 589751
45
         8
             8 551205
                        0.000000 0 226 588103
              2 559018 211.750000
                                  0 226 595743
46
         3
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48 5 5 555634 174.250000 0 226 594667 49 10 8 538266 170.500000 2 226 588651 50 9 5 546391 139.000000 2 225 588651 51 3 3 533536 198.000000 2 225 584867 53 8 8 549850 194.000000 2 225 591210 54 5 4 551360 205.000000 2 225 591210 56 16 9 568271 275.125000 0 224 60948 57 14 9 563626 250.142857 0 224 60948 58 8 5 555423 212.600000 224 60946 60 12 8 559317 28.00000 1 224 595766 61 5 5 51622 187.00000 1 <th>47</th> <th>2</th> <th>1</th> <th>554701</th> <th>164.400000</th> <th>0</th> <th>226</th> <th>592746</th>	47	2	1	554701	164.400000	0	226	592746
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79 22 16 538287 255.166667 1 231 549608 80 23 15 529271 219.3333333 1 232 542717 81 27 21 514177 224.000000 2 234 533284 82 20 16 520627 256.166667 2 235 537875 84 23 15 526663 272.333333 3 235 540350 84 23 15 526663 272.3333333 3 235 540294 85 27 19 522011 212.000000 3 235 537581 86 20 16 523749 218.166667 1 235 535509 87 36 18 518884 197.250000 5 242 535509 88 15 14 520384 175.666667 5 242 53613 90 51 30 503459					201.125000			
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91 40 29 304795 235.000000 7 244 332081 92 29 20 296312 250.500000 7 243 321938 93 23 13 302868 262.400000 6 243 330055 94 38 19 303630 245.800000 1 243 331511 95 19 12 303743 238.400000 2 242 331555 96 34 18 296275 0.000000 1 243 324253 97 42 17 298039 0.000000 1 243 325322 98 39 21 296472 0.000000 2 243 324116 99 37 19 298975 0.000000 2 243 326462 100 72 23 301194 0.000000 2 243 329363 101 29 18 291989 <	89	37	23	514266	260.000000	7	243	533633
92 29 20 296312 250.500000 7 243 321938 93 23 13 302868 262.400000 6 243 330055 94 38 19 303630 245.800000 1 243 331511 95 19 12 303743 238.400000 2 242 331555 96 34 18 296275 0.000000 1 243 324253 97 42 17 298039 0.000000 1 243 325322 98 39 21 296472 0.000000 2 243 324116 99 37 19 298975 0.000000 2 243 326462 100 72 23 301194 0.000000 2 243 330363 101 29 18 291989 209.3333333 2 243 321391 103 48 24 298780 170.000000 2 242 324731 104 35 21 <								
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112 376 145 289245 252.285714 15 253 313114								
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115	249	109	289748	238.666667	1	256	313547
116	177	91	289305	224.000000	1	258	313285
117	202	91	286865	265.400000	0	259	310034
118	238	102	286719	0.000000	0	259	309043
119	232	110	319810	273.666667	0	260	346724
120	213	105	346051	268.500000	0	260	372202
121 122	197 235	101 103	346047 343872	246.500000 236.666667	1 1	261 262	371050 369772
123	235 156	81	344405	281.000000	1	263	369834
124	160	76	343862	265.250000	1	263	369326
125	196	84	346059	231.333333	1	263	370906
126	157	81	349684	284.000000	2	267	375800
127	138	78	360898	0.000000	2	268	382880
128	144	73	386061	268.500000	5	268	391894
129	150	69	391598	385.333333	5	268	389624
130	113	63	394795	157.000000	5	268	389928
131	101	58	405264	0.000000	5	269	394679
132	115	64	414517	298.500000	5	269	410553
133 134	121 136	74 72	417999 422942	328.800000 321.888889	0	269 269	414197 428815
134	103	68	422942	283.833333	0	269	443553
136	95	60	436288	0.000000	1	271	450759
137	134	64	443198	341.000000	1	271	425344
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139	113	70	327410	0.000000	1	272	350773
140	96	62	317937	0.000000	1	272	346522
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161	73	54	483667	267.000000	0	276	482486
162	108	59	483748	269.000000	0	277	482538
163	103	62	482615	326.000000	0	278	481650
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165	84	43	492936	359.666667	1	280	491073
166	103	60 50	489948 434017	276.000000	1 2	279	489249
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170	69	44	341031	243.800000	4	279	366392
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172	88	55	342191	0.000000	12	279	367981
173	100	45	320266	246.000000	12	279	348232
174	92	55	322116	266.800000	12	279	349562
175	119	59	298233	0.000000	12	279	329730
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178	60	45	302433	0.00000	4	279	227217

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182	96	54	363454	297.750000	19	280	381413
183	61	40	351333	239.000000	19	280	377496
184	192	91	300267	209.666667	19	281	325742
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186	109	58	210302	299.000000	11	282	243481
187	144	67	176641	406.500000	11	282	208842
188	131	69	177477	332.222222	11	283	210718
189	126	61	177484	317.125000	11	284	210535
190 191	126 163	75 76	153947 146085	295.500000 401.000000	11 11	284 285	184902 174231
191	101	55	144346	362.000000	11	286	174231
193	121	59	146917	366.333333	11	286	175702
194	124	57	138904	274.000000	11	287	167285
195	119	64	134556	282.000000	11	288	161989
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197	80	51	131819	289.400000	11	289	159573
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200	113	47	104512	335.800000	11	291	127138
201	407	153	105466	340.800000	11	292	130204
202	1586	382	109977	321.250000	11	293	134714
203 204	1797 1582	448 428	116828 217453	349.571429 342.714286	11 11	293 294	141243 219782
205	1493	434	83294	392.000000	12	295	84028
206	1305	393	168118	327.875000	12	300	169789
207	1219	347	156445	334.333333	14	301	158675
208	1165	384	153901	608.000000	14	300	156071
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210	1063	351	80903	288.666667	6	298	82616
211	797	317	72195	355.250000	6	298	75459
212	746	305	72189	317.500000	6	300	75488
213	546	268	67869	512.500000	5	301	71181
214	536	264	67557	476.777778	2	301	70805
215	541	252	67827	421.000000	3	300	71125
216 217	481 428	247 242	73344 72847	365.000000	3 7	302 300	76556 76133
217	454	242	78202	402.500000	7	300	80852
219	476	238	80717	0.000000	7	303	82991
220	440	225	83704	393.333333	7	304	84969
221	381	220	83581	356.000000	10	304	84899
222	409	221	100334	355.000000	9	304	101265
223	426	225	83775	0.000000	9	305	85045
224	406	210	84469	451.000000	9	305	85410
225	444	222	84318	346.333333	8	306	85348
226	513	226	84332	0.000000	8	306	85392
227	389	229	84334	370.000000	8	306	85405
228 229	333 312	203 185	84448 84485	0.000000 359.000000	4 5	306 305	85519 85603
230	383	205	84623	0.000000	2	305	85684
231	405	218	84594	300.000000	2	307	85662
232	408	219	84559	0.000000	2	309	85688
233	451	221	84647	338.666667	2	310	85764
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235	302	180	84472	361.000000	2	311	85676
236	321	188	84721	317.000000	2	312	85838
237	378	219	84769	301.000000	2	312	85867
238	369	222	83840	378.000000	2	312	85403
239	464	234	84668	295.666667	2	313	85884
240	435	226	84659	305.600000	5	314	85885
241 242	353 292	198 173	84581 84597	243.000000 389.000000	6 6	316 316	85830 85852
242	423	228	81765	0.000000	4	315	83779
244	429	213	82769	593.000000	7	318	84434
					,		

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246	434	239	86016	372.000000	11	318	86785
247	406	215	83756	369.000000	9	317	85547
248	385	182	80396	389.000000	13	318	82960
249	284	172	79956	351.000000	13	319	82590
250	361	187	79071	0.000000	13	318	81831
251	319	158	80134	429.500000	9	321	82787
252	355	175	79797	418.000000	6	321	82410
253 254	356 378	168 184	74877 79293	270.600000	6 0	321 322	90182 93858
255	299	184	68613	412.000000	0	322	82709
256	241	136	64688	430.000000	0	322	79075
257	327	159	69767	0.000000	0	321	83645
258	352	164	74374	492.000000	5	321	88270
259	239	158	72278	360.000000	8	321	85491
260	269	163	67766	278.000000	9	321	81554
261	354	180	72594	300.000000	9	321	86682
262	278	169	77077	0.000000	9	321	90728
263	275	175	78359	0.000000	9	323	91986
264	290	168	77416	0.000000	9	324	91402
265	337	186 193	79071 77361	0.000000	3	324	92734
266 267	438 475	189	75410	0.000000	0	324 325	91465 90048
268	372	168	45644	0.000000	0	326	57869
269	437	179	51472	0.000000	3	326	63678
270	520	194	48379	0.000000	3	326	60840
271	333	181	73087	441.000000	3	326	86798
272	306	182	71852	439.000000	3	326	85545
273	356	182	74298	395.000000	3	325	87662
274	358	205	74700	400.333333	5	327	88098
275	317	175	80506	0.00000	5	327	93917
276	386	167	56367	347.333333	2	327	68739
277	339	165	53648	0.000000	4	327	66156
278 279	282 274	158 171	54734 474438	323.666667 402.500000	4	327 327	67437 474638
280	314	165	86078	387.500000	4	326	99358
281	323	178	85292	365.000000	4	327	98254
282	269	171	79047	620.000000	4	327	92475
283	263	170	81394	566.500000	4	329	94672
284	275	175	74827	486.000000	2	329	88902
285	265	169	146415	0.000000	5	329	155077
286	306	179	489974	565.000000	11	327	490071
287	227	128	390456	419.500000	14	327	390707
288	302	167	390393	359.000000	12	328	390729
289	267 361	163	454868	0.000000	12	328	455351
290 291	255	175 148	455749 443108	0.000000	12 12	327 326	455789 444004
292	302	159	444982	471.000000	9	327	445170
293	317	150	442715	452.666667	1	328	443624
294	294	151	436807	0.000000	0	328	437346
295	375	160	410615	0.000000	0	329	407557
296	303	130	406252	0.000000	1	329	406498
297	344	163	137501	595.000000	1	329	138523
298	397	184	405398	561.000000	1	328	405896
299	339	147	405649	341.000000	1	328	406237
300 301	355	150	391967	0.000000 432.000000	3	328 328	392593
301	298 385	155 158	392317 389303	0.000000	2	328	392979 389671
303	335	155	131185	336.500000	2	332	128200
304	230	141	87725	0.000000	2	332	88743
305	271	142	93311	465.000000	2	333	94242
306	298	161	92886	0.000000	2	333	93893
307	307	156	93130	406.000000	0	334	94087
308	284	165	106199	389.000000	0	335	106344
309	286	150	105800	0.000000	0	335	105617
310	308	139	104196	0.000000	0	335	105128

12	311	299	144	90598	0.000000	0	335	91376
313 305 157 90654 508.000000 0 337 91402 314 311 153 376423 384.000000 0 337 379554 316 278 167 379950 418.000000 0 337 379554 318 238 136 388479 0.000000 0 337 389748 319 247 137 386878 425.000000 0 337 389137 320 192 118 391298 0.000000 0 337 391892 321 223 155 390244 0.000000 0 336 399812 323 257 156 394205 569.00000 0 336 394523 324 317 184 394437 0.000000 0 336 394523 324 317 184 394431 0.000000 0 334 3949560 327 286 152								
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318 238 136 388479 0.000000 0 337 3881748 319 247 137 386878 425,000000 0 337 381837 320 192 118 391298 0.000000 0 337 391889 321 223 155 390244 0.000000 0 336 394812 322 253 144 390109 424,000000 0 336 394523 324 317 184 394347 0.000000 0 336 394601 326 257 132 394532 0.000000 0 334 394769 327 286 152 394606 0.000000 0 334 394853 327 286 152 394606 0.000000 0 334 394690 327 286 152 394606 0.000000 0 334 394769 328 390 142	316	278	167	379950	418.000000	0	336	380270
319	317	257	144	376015	424.500000	0	337	377551
320 192 118 391298 0.000000 0 337 391892 321 223 155 390244 0.000000 0 336 390812 322 257 156 394280 569.000000 0 336 394523 324 317 184 394347 0.000000 0 336 394603 326 257 132 394532 0.000000 0 334 394769 327 286 152 394606 0.000000 0 334 394769 328 309 142 394714 0.000000 0 334 394560 330 291 179 394777 532.33333 0 334 395060 330 291 179 394777 532.33333 0 334 395060 331 316 151 394976 0.000000 0 337 395125 333 266 142						0		
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333 266 142 394976 0.000000 0 337 395255 334 290 148 392975 0.000000 0 337 393730 335 287 166 392828 490.333333 0 337 395344 337 251 157 371312 400.000000 0 338 373179 338 249 158 369610 298.00000 0 338 370202 339 230 152 367034 0.000000 1 338 369376 340 210 140 366199 467.50000 1 338 368415 341 198 135 365574 0.000000 1 338 366753 342 225 145 365041 0.000000 1 340 376394 344 229 141 139948 0.000000 1 340 376394 344 229 141	331	316	151	394907	0.00000	0	336	395185
334 290 148 392975 0.000000 0 337 393730 335 287 166 392828 490.3333333 0 337 393648 336 255 168 394892 449.000000 0 337 395344 337 251 157 371312 400.000000 0 338 370202 339 230 152 367034 0.000000 1 338 369376 340 210 140 366199 467.50000 1 338 369376 341 198 135 365574 0.000000 1 338 366753 342 225 145 365041 0.000000 1 340 376394 344 229 141 139948 0.000000 1 340 159312 345 249 151 135604 0.000000 1 340 160070 346 246 135	332	283	157	394836	653.500000	0	337	395125
335 287 166 392828 490.333333 0 337 393648 336 255 168 394892 449.000000 0 337 395344 337 251 157 371312 400.00000 0 338 373179 338 249 158 369610 298.000000 0 338 373179 340 210 140 366199 467.500000 1 338 369376 341 198 135 365574 0.000000 1 338 366754 343 225 143 374382 0.000000 1 340 376394 344 229 141 139948 0.000000 1 340 159312 345 249 151 135604 0.000000 1 340 159312 347 209 139 478705 511.000000 0 340 480199 347 209 139				394976		0		
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	376	135	92	207119	620.000000	0	345	208547

377	171	116	204629	0.000000	0	344	206141
378	172	104	197569	542.000000	0	343	198671
379	150	100	203459	613.000000	1	343	204867
380	214	125	126430	386.500000	4	345	127226
381	178	108	273698	297.500000	4	345	274046
382	211	111	273031	0.00000	4	345	273451
383	173	117	278761	501.000000	4	346	279410
384	145	108	156151	567.000000	4	346	166819
385	164	104	110515	565.333333	4	346	111887
386	178	107	79881	461.000000	3	346	81606
387	183	112	80435	0.000000	1	346	81771
388 389	216 384	116 309	79983 271420	0.000000	3	348 348	81414 272709
390	274	166	271420	0.000000	3	348	272709
391	214	115	275886	337.500000	3	348	276341
392	174	109	83187	0.000000	3	348	84374
393	165	119	272007	0.00000	3	348	273396
394	152	103	269272	0.00000	3	348	270475
395	167	111	171768	705.500000	1	348	146495
396	178	114	135110	684.000000	2	347	136226
397	176	107	132527	440.500000	2	345	133685
398	139	102	104630	381.500000	10	342	105796
399	201	115	115840	411.333333	12	342	116954
400	194	110	105027	376.600000	13	342	105770
401	157	110	133189	345.500000	12	341	134800
402 403	177 151	107 95	132302 130351	0.000000 544.000000	12 14	341 341	133853 131985
403	149	109	150495	389.500000	14	344	162668
405	164	120	152541	333.000000	9	344	161286
406	210	107	154716	573.500000	8	344	169757
407	126	91	93046	484.666667	7	344	93927
408	344	149	81542	414.375000	10	345	82472
409	324	156	148644	321.000000	13	346	164471
410	214	106	143247	418.000000	10	346	160029
411	452	165	144610	453.500000	10	345	160399
412	433	150	136486	393.000000	7	348	147009
413	429	152	143148	592.000000	7	349	158677
414	317	138	140789	511.000000	7	350	156182
415	411 311	142 131	136205 137048	0.000000	4	350 351	152013 153117
416 417	329	124	137046	0.000000	0	351	155707
418	381	137	138363	478.500000	0	351	155280
419	353	123	74974	0.000000	0	351	86951
420	360	134	133509	0.00000	0	351	148445
421	284	129	131246	678.500000	0	352	149303
422	230	123	137594	545.500000	0	352	149248
423	277	118	128995	478.666667	0	354	144237
424	201	111	131142	395.000000	0	354	146172
425	259	139	127286	407.400000	0	355	142567
426	327	137	131724	386.000000	0	357	146274
427 428	393	132	129964	0.000000	0	359 359	142071
420	248 225	143 143	126700 128650	392.666667	0 1	359	139067 141048
430	254	106	123625	284.000000	1	359	136816
431	203	109	126834	484.000000	1	358	139761
432	233	160	128868	448.000000	1	357	141862
433	407	307	125037	371.000000	1	357	141271
434	312	198	121657	349.000000	1	357	140935
435	278	131	210626	0.000000	1	357	200335
436	277	144	207869	490.000000	0	358	197464
437	214	109	215188	356.000000	0	357	212084
438	199	121	216360	363.200000	2	358	211717
439	234	127	214338	0.000000	3	356	204617
440	197	104	213310	526.000000	3	356	213465
441 442	227 211	132 135	218547 223983	341.600000 325.000000	5 10	356 354	202373 206637
444	Z 1 1	133	<u> </u>	JZJ.000000	ΤU	554	20003/

1444	443	185	124	225413	0.000000	10	355	205982
446 196 115 249043 372.500000 8 356 239129 447 214 127 252074 0.000000 5 356 236071 448 185 117 202575 0.000000 1 357 215754 450 174 96 204089 409.500000 1 357 215754 451 172 99 203267 0.000000 0 356 223681 452 136 93 202665 374.000000 0 356 223614 453 183 102 214882 0.000000 0 356 221742 455 157 106 212867 338.00000 0 356 21734 455 157 101 208083 0.000000 0 356 215595 457 194 101 208080 0.00000 0 356 215695 458 179 101 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								
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462 134 95 201336 307.000000 0 355 208523 463 174 106 202520 0.000000 0 354 213401 464 127 80 206397 0.000000 0 354 221719 466 187 92 206312 0.000000 0 354 221719 466 187 92 206312 0.000000 0 354 221719 466 187 92 206312 0.000000 0 354 208308 468 148 87 200304 620.000000 0 355 206939 469 154 113 196062 567.000000 0 355 206939 471 164 93 198829 470.000000 0 355 208047 472 128 86 199593 0.000000 0 355 206845 473 137 92 1								
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464 127 80 206397 0.000000 0 353 217183 465 144 98 209917 0.000000 0 354 221719 466 187 92 206312 0.000000 0 354 218000 467 177 104 205545 586.000000 0 354 208799 469 154 113 196062 567.000000 0 355 206939 470 155 105 193449 656.000000 0 355 206939 471 164 93 198829 470.00000 0 355 206939 471 164 93 198829 470.00000 0 355 208939 471 164 93 198698 0.000000 0 355 208045 472 128 86 196953 0.000000 0 355 206645 474 120 79								
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508 186 85 197290 0.000000 0 367 215599								
	508	186	85	197290	0.000000	0	367	215599

509	226	104	197707	0.000000	0	367	216407
510	149	101	194372	0.000000	0	367	214011
511	177	119	193151	0.000000	0	366	213490
512	189	102	207535	505.000000	0	366	226366
513	168	99	208233	416.500000	0	366	226834
514	201	87	199393	0.000000	1	367	219295
515	130	76	202501	0.000000	1	368	222335
516	178	101	198891	0.000000	1	367	219410
517	146	99	196651	0.00000	1	367	217766
518	124	79	193603	0.000000	1	367	215172
519	125	94	191422	0.000000	6	367	213120
520 521	147 122	95 94	178585 176328	0.000000	6 5	367 367	200714 198909
522	106	78	173750	0.000000	5	367	196521
523	129	88	182049	315.750000	5	367	203594
524	140	93	180046	0.000000	5	367	201658
525	161	85	178864	487.333333	5	367	200640
526	174	102	179979	387.500000	0	366	201731
527	142	83	179326	0.000000	0	366	201045
528	112	85	180194	0.000000	0	367	201582
529	109	85	188933	0.000000	0	367	211050
530	104	72	186785	0.000000	0	367	209433
531	128	87	184783	418.000000	0	367	208131
532	159	103	182659	0.000000	1	367	207083
533	125	96	185255	0.00000	1	367	209219
534	126	92	188019	0.000000	1	368	211647
535	93	77	189455	0.000000	1	368	212742
536	102	79	188008	0.000000	1	367	211463
537 538	93 105	74 77	185769 182183	0.000000 519.000000	1	367 367	209366 206069
539	135	109	184224	0.000000	0	367	207421
540	104	72	188417	379.000000	0	367	210772
541	130	102	167429	767.000000	0	367	191301
542	170	95	167371	0.000000	0	366	191400
543	125	86	171055	0.00000	0	366	194453
544	143	82	170906	0.000000	0	366	194640
545	132	86	170680	0.000000	0	366	194550
546	123	90	183220	585.000000	0	366	206789
547	127	90	185749	0.000000	0	366	209485
548	129	86	195792	333.666667	0	366	218675
549	100	73	193640	0.00000	0	366	217194
550	129	87	190217	0.000000	0	365	214396
551	91	75 75	188106	0.000000	0	365	212330
552 553	107 112	75 91	192868 191441	0.000000	0	365 366	216490 214965
554	150	96	188660	0.000000	0	366	214903
555	148	106	186542	0.000000	0	366	211061
556	116	71	192326	0.000000	0	366	215632
557	105	78	176393	0.000000	0	366	200355
558	128	88	178235	564.000000	0	366	201898
559	121	95	180723	0.000000	0	366	203865
560	214	113	182655	0.000000	1	365	205795
561	138	92	176690	0.000000	1	365	200426
562	143	103	172898	0.000000	2	366	196684
563	193	107	176476	0.00000	2	366	199554
564	148	74	195542	0.000000	2	367	217194
565	195	107	184383	628.000000	2	366	208283
566	190	103	185287	0.000000	0	368	209004
567 568	166 151	99	186172	0.000000	1 2	368	209553
568 569	151 161	107 106	179959 184686	0.000000	4	368 369	203856 207904
570	135	106	176942	0.000000	4	369	207904
571	146	85	179493	0.000000	4	368	201213
572	169	103	179679	0.000000	4	368	203010
573	156	99	179606	0.000000	4	370	203351
574	148	107	183315	0.000000	4	370	206703

576 167 103 163972 0.000000 0 370 188083 577 190 108 163344 0.000000 370 188748 579 134 100 164531 0.000000 370 187582 580 176 112 70581 0.000000 370 187582 580 176 112 70581 0.000000 370 187582 580 176 112 70581 0.000000 370 183620 582 180 105 93105 0.000000 370 109935 583 217 16 9578 24,000000 370 102921 584 115 33 84317 0.000000 370 102921 585 153 103 85672 0.000000 369 198229 586 179 116 178569 0.000000 368 197171 588 160 115 175	575	152	110	163769	0.000000	0	370	188628
577 190 108 163364 0.000000 0 370 188744 579 134 100 164531 0.000000 0 370 188784 580 176 112 70581 0.000000 0 370 188448 581 192 118 68621 445.000000 0 370 19935 582 180 105 93105 0.000000 0 370 109935 584 115 83 84317 0.000000 0 370 102975 585 153 103 85672 0.000000 0 370 102935 586 179 116 178674 0.000000 0 369 198229 588 160 114 174595 0.000000 0 369 198229 588 160 114 174595 0.000000 0 367 19986 599 162 115 172809								
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	640	92	70	147921	0.000000	3	368	176678

641	114	84	163246	0.000000	3	367	192698
642	127	83	164039	0.000000	3	367	193488
643	110	89	164348	376.250000	13	368	193759
644	94	76	161081	0.00000	11	370	190975
645	95	78	160728	465.000000	12	370	190149
646	199	114	145553	402.000000	16	371	174517
647	117	76	140862	0.00000	16	372	170358
648	112	71	157238	612.000000	16	372	187196
649	249	126	137573	515.000000	15	373	167402
650	185	90	135038	0.000000	5	373	164676
651	123	95	137122	0.000000	5	373	166167
652 653	108 133	77 85	138403 141684	0.000000 412.000000	0	374 374	166467 168679
654	222	103	141004	367.666667	0	375	167178
655	153	106	136841	0.000000	0	375	163913
656	186	107	137575	0.000000	0	375	164482
657	187	95	135642	0.000000	0	376	162632
658	196	129	129767	360.000000	0	377	157028
659	208	112	141365	0.00000	0	378	170130
660	195	117	139969	0.00000	0	379	168785
661	154	96	135621	0.00000	0	380	164893
662	253	175	132797	0.00000	0	381	161959
663	349	203	131006	291.500000	2	381	160044
664	306	163	128797	0.000000	2	381	157601
665	396	148	117195	0.00000	2	381	143391
666	313	153	116277	0.000000	2	381	142352
667	312	151	114926	559.000000	2	382	140372
668	51	39	379454	186.250000	0	226	465864
669 670	85 116	69 38	404875 407748	168.500000 164.666667	0	226 227	487377 494572
671	39	30 21	407746	179.000000	0	227	494572
672	19	54	411552	180.666667	0	227	497810
673	49	28	415817	225.250000	0	227	501227
674	35	33	414664	190.000000	0	226	500469
675	50	26	414341	180.000000	0	226	500399
676	36	12	413918	207.666667	0	226	500335
677	31	35	415214	169.000000	0	227	501318
678	17	201	413591	0.00000	0	226	500659
679	20	175	408760	171.500000	0	226	496706
680	36	30	399549	0.000000	0	226	484701
681	62	15	399135	193.285714	0	226	484657
682	138	18	406383	161.666667	0	225	488540
683	240	20	417056	148.333333	0	225	494006
684 685	20 27	41 14	418699 426139	148.600000 123.000000	0	225 225	494503 498981
686	13	16	420139	0.000000	0	225	501102
687	17	10	438659	0.000000	0	225	507319
688	24	60	445913	160.222222	0	225	511525
689	46	55	448515	105.500000	0	225	512635
690	33	98	452730	127.000000	0	226	514821
691	24	68	341602	0.00000	0	225	382407
692	12	33	343616	0.00000	0	226	384935
693	19	39	333774	138.000000	0	226	374229
694	23	37	322209	146.000000	0	227	366514
695	39	28	312061	178.200000	0	227	362294
696	35	29	324869	162.800000	0	227	371120
697	19	38	282651	160.600000	0	227	334575
698	53	25	285552	196.571429	0	227	336553
699 700	191	63 55	290998	165.909091	2	227	341518
700	226 153	55 47	288818 283728	175.500000 203.666667	3	227 227	338022 332444
701	249	27	288997	218.666667	3	228	334539
702	202	27	296078	168.750000	3	228	341988
704	94	27	299220	177.833333	3	228	345197
705	81	26	448821	168.333333	3	227	502606
706	165	23	472256	159.333333	0	228	522166

Tobal	707	106	25	481960	165.000000	0	229	530635
709 164 20 539644 0.000000 0 226 578030 710 144 18 547905 165.800000 0 226 578030 711 163 34 555210 142.666667 0 225 588103 713 100 31 551205 0.000000 0 226 588103 714 82 42 559018 211.750000 0 226 592746 716 108 36 555634 174.250000 0 226 594567 717 175 23 538266 170.500000 2 225 5881616 718 107 9 48 541360 0.000000 2 225 588093 720 94 48 541360 0.000000 2 225 581921 721 120 39 54856 194.000000 2 225 581936 722 134 31								
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713 100 31 551205 0.000000 0 226 595743 714 82 42 559018 211.750000 0 226 595743 715 97 49 554701 164.400000 0 226 594567 717 175 23 538266 170.500000 2 226 581016 718 107 9 546391 139.000000 2 225 580167 719 158 17 533536 198.000000 2 225 584867 721 120 39 549850 194.000000 2 225 58121 721 120 39 549850 194.000000 2 225 591896 721 120 39 549850 194.000000 2 225 591896 722 134 31 551362 250.142857 224 606940 722 159 15 568271	711	162		562240	162.000000	0	226	594268
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767 715 239 298975 0.0000000 2 243 326462 768 939 205 301194 0.0000000 2 243 330363 769 694 109 291989 209.3333333 2 243 319283 770 699 202 294750 223.818182 2 243 321391 771 791 385 298780 170.000000 2 242 324731								
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769 694 109 291989 209.3333333 2 243 319283 770 699 202 294750 223.818182 2 243 321391 771 791 385 298780 170.000000 2 242 324731								
770 699 202 294750 223.818182 2 243 321391 771 791 385 298780 170.000000 2 242 324731								
771 791 385 298780 170.000000 2 242 324731								
				302653	342.000000	2		

773	708	175	300100	322.500000	2	242	327346
774	872	185	298970	253.200000	2	243	326690
775	1413	571	291076	232.777778	11	246	318276
776	1409	536	296041	243.166667	14	249	322192
777	1382	562	294639	247.352941	14	251	320722
778	1046	570	293293	245.333333	15	252	319200
779	1254	562	289527	241.000000	15	252	313790
780	1256	518	289245	252.285714	15	253	313114
781	1044	528	287850	304.400000	15	255	311772
782	1027	535	288704	244.333333	1	257	312846
783 784	948	431 409	289748	238.666667	1 1	256	313547 313285
785	1087 705	460	289305 286865	224.000000 265.400000	0	258259	313263
786	703	444	286719	0.000000	0	259	309043
787	698	439	319810	273.666667	0	260	346724
788	653	499	346051	268.500000	0	260	372202
789	714	558	346047	246.500000	1	261	371050
790	768	460	343872	236.666667	1	262	369772
791	726	478	344405	281.000000	1	263	369834
792	750	616	343862	265.250000	1	263	369326
793	707	633	346059	231.333333	1	263	370906
794	668	554	349684	284.000000	2	267	375800
795	600	564	360898	0.000000	2	268	382880
796	664	509	386061	268.500000	5	268	391894
797	600	442	391598	385.333333	5	268	389624
798 799	663 683	401 408	394795 405264	157.000000	5 5	268269	389928 394679
800	930	344	414517	298.500000	5	269	410553
801	1001	325	417999	328.800000	0	269	414197
802	747	277	422942	321.888889	0	269	428815
803	516	283	425865	283.833333	0	269	443553
804	617	247	436288	0.000000	1	271	450759
805	509	259	443198	341.000000	1	271	425344
806	650	246	403181	0.00000	1	271	414166
807	698	266	327410	0.00000	1	272	350773
808	377	284	317937	0.000000	1	272	346522
809	507	251	395475	0.00000	1	272	415089
810	384	245	400203	297.750000	1	271	419045
811	399	222	405490	237.000000	0	271	423495
812 813	441 365	243 237	405219 405969	308.250000	0	271271	424297 424953
814	334	261	406543	0.000000	0	271	424955
815	484	275	413620	257.000000	0	271	429003
816	435	272	418538	0.000000	0	271	424274
817	474	266	426097	0.00000	1	271	429792
818	346	228	410436	311.333333	1	271	426634
819	342	224	412520	261.000000	3	271	425788
820	388	293	410440	0.00000	3	272	425318
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823	394	251	428296	368.333333	3	272	443558
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825 826	425 378	206 235	429076 468058	280.000000	0	273273	443646 470433
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828	371	191	483726	297.250000	0	274	482386
829	303	201	483667	267.000000	0	276	482486
830	353	196	483748	269.000000	0	277	482538
831	477	199	482615	326.000000	0	278	481650
832	443	239	450708	316.000000	0	278	446642
833	429	247	492936	359.666667	1	280	491073
834	309	1007	489948	276.000000	1	279	489249
835	433	1056	434017	271.000000	2	279	435777
836	380	810	391444	241.250000	2	280	402606
837	361	724	359109	0.000000	2	279	379892
838	455	657	341031	243.800000	4	279	366392

839	444	645	341960	209.000000	12	279	367293
840	321	651	342191	0.000000	12	279	367981
841	384	289	320266	246.000000	12	279	348232
842	342	217	322116	266.800000	12	279	349562
843	352	185	298233	0.00000	12	279	329730
844	346	234	307554	283.000000	4	279	336751
845	278	224	306545	274.000000	4	279	335365
846	294	197	302433	0.000000	4	279	332512
847 848	299 308	189 284	318140 344569	277.000000	4 19	279 279	346529 370574
849	306	362	344369	326.500000	19	280	370574
850	321	317	363454	297.750000	19	280	381413
851	344	282	351333	239.000000	19	280	377496
852	509	373	300267	209.666667	19	281	325742
853	357	387	246090	304.000000	19	281	277955
854	354	387	210302	299.000000	11	282	243481
855	299	367	176641	406.500000	11	282	208842
856	349	279	177477	332.22222	11	283	210718
857	298	303	177484	317.125000	11	284	210535
858	264	296	153947	295.500000	11	284	184902
859 860	340 301	290 272	146085 144346	401.000000 362.000000	11 11	285 286	174231 172816
861	270	296	144340	366.333333	11	286	175702
862	307	549	138904	274.000000	11	287	167285
863	331	547	134556	282.000000	11	288	161989
864	371	486	130237	295.600000	11	289	157344
865	367	452	131819	289.400000	11	289	159573
866	357	678	126596	247.333333	11	290	153081
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868	240	504	104512	335.800000	11	291	127138
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870	2302	1421	109977	321.250000	11	293	134714
871 872	2241	1483 1510	116828	349.571429 342.714286	11	293	141243 219782
873	2383 2263	1548	217453 83294	392.000000	11 12	294295	84028
874	1796	1522	168118	327.875000	12	300	169789
875	1464	1368	156445	334.333333	14	301	158675
876	1709	1446	153901	608.000000	14	300	156071
877	1656	1355	81179	335.600000	14	299	82756
878	1438	1325	80903	288.666667	6	298	82616
879	1466	1360	72195	355.250000	6	298	75459
880	1444	1366	72189	317.500000	6	300	75488
881	1179	1263	67869	512.500000	5	301	71181
882	1215	1161	67557	476.777778	2	301	70805
883 884	1134 1463	1143 1154	67827 73344	421.000000 365.000000	3	300 302	71125 76556
885	1148	1121	73344	0.000000	7	302	76133
886	1293	1099	78202	402.500000	7	302	80852
887	1429	1084	80717	0.000000	7	303	82991
888	1694	1035	83704	393.333333	7	304	84969
889	2116	1026	83581	356.000000	10	304	84899
890	2177	2147	100334	355.000000	9	304	101265
891	2210	2317	83775	0.000000	9	305	85045
892	2164	2064	84469	451.000000	9	305	85410
893	1715	1940	84318	346.333333	8	306	85348
894	2605	1932	84332	0.000000	8	306 306	85392
895 896	1740 1670	1877 1731	84334 84448	0.000000	8 4	306	85405 85519
897	2897	1207	84485	359.000000	5	305	85603
898	2810	1081	84623	0.000000	2	305	85684
899	3027	1093	84594	300.000000	2	307	85662
900	1902	1101	84559	0.000000	2	309	85688
901	2241	1139	84647	338.666667	2	310	85764
902	1997	1122	84562	451.500000	2	310	85692
903	2240	1032	84472	361.000000	2	311	85676
904	1635	2544	84721	317.000000	2	312	85838

905	3168	2570	84769	301.000000	2	312	85867
906	4571	2289	83840	378.000000	2	312	85403
907	6247	2235	84668	295.666667	2	313	85884
908	2850	2255	84659	305.600000	5	314	85885
909	3579	2298	84581	243.000000	6	316	85830
910	5709	2028	84597	389.000000	6	316	85852
911	4381	1624	81765	0.00000	4	315	83779
912	4392	1512	82769	593.000000	7	318	84434
913	3780	1547	82132	348.750000	8	318	84115
914	5055	1523	86016	372.000000	11	318	86785
915	5823	1553	83756	369.000000	9	317	85547
916 917	3207 4599	1373 1254	80396 79956	389.000000 351.000000	13 13	318 319	82960 82590
917	6185	1373	79930	0.000000	13	318	81831
919	6306	1350	80134	429.500000	9	321	82787
920	7532	1356	79797	418.000000	6	321	82410
921	7512	1299	74877	270.600000	6	321	90182
922	4774	1289	79293	0.00000	0	322	93858
923	4409	1195	68613	412.000000	0	322	82709
924	4005	1150	64688	430.000000	0	322	79075
925	6340	1226	69767	0.00000	0	321	83645
926	5385	1230	74374	492.000000	5	321	88270
927	4846	1217	72278	360.000000	8	321	85491
928	2869	1150	67766	278.000000	9	321	81554
929	5304 4750	1230	72594	300.000000	9	321	86682
930 931	4750	1288 1246	77077 78359	0.000000	9	321 323	90728 91986
932	4694	1413	77416	0.000000	9	324	91402
933	4337	1451	79071	0.000000	3	324	92734
934	3901	1425	77361	0.000000	0	324	91465
935	3703	1337	75410	0.00000	0	325	90048
936	3854	1387	45644	0.00000	0	326	57869
937	3719	1436	51472	0.00000	3	326	63678
938	3685	1301	48379	0.00000	3	326	60840
939	4447	1352	73087	441.000000	3	326	86798
940	3124	1263	71852	439.000000	3	326	85545
941	3068	1304	74298	395.000000	3	325	87662
942	3698	1276	74700	400.333333	5	327	88098
943 944	3302 3508	1349 1333	80506 56367	0.000000 347.333333	5 2	327 327	93917 68739
945	3523	1298	53648	0.000000	4	327	66156
946	3757	3294	54734	323.666667	4	327	67437
947	3436	3435	474438	402.500000	4	327	474638
948	4477	2913	86078	387.500000	4	326	99358
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950	3767	2538	79047	620.000000	4	327	92475
951	3610	2540	81394	566.500000	4	329	94672
952	3387	2464	74827	486.000000	2	329	88902
953	2441	3783	146415	0.000000	5	329	155077
954	2583	3454	489974	565.000000	11	327	490071
955 956	2624	3169	390456	419.500000	14	327	390707
957	2596 2541	3002 2870	390393 454868	359.000000	12 12	328 328	390729 455351
958	2341	2772	455749	0.000000	12	327	455789
959	2039	2724	443108	0.000000	12	326	444004
960	2673	1929	444982	471.000000	9	327	445170
961	1894	1611	442715	452.666667	1	328	443624
962	2107	1535	436807	0.000000	0	328	437346
963	2094	1477	410615	0.000000	0	329	407557
964	2502	1307	406252	0.000000	1	329	406498
965	1757	1426	137501	595.000000	1	329	138523
966	1866	1413	405398	561.000000	1	328	405896
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968 969	2842	2244	391967	0.000000 432.000000	3	328	392593
969 970	2138 1466	2004 1884	392317 389303	0.000000	3 2	328 332	392979 389671
210	TAOO	1004	509503	0.00000		J J Z	JUJU/1

971	1538	1751	131185	336.500000	2	332	128200
972	1855	1716	87725	0.000000	2	332	88743
973	2451	1795	93311	465.000000	2	333	94242
974	1858	1613	92886	0.000000	2	333	93893
975	1594	1443	93130	406.000000	0	334	94087
976	1933	1493	106199	389.000000	0	335	106344
977	2015	1447	105800	0.000000	0	335	105617
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979	2242	1404	90598	0.000000	0	335	91376
980	1714	1276	90853	449.500000	0	335	91589
981 982	1663 1830	1417 1283	90654 376423	508.000000 384.000000	0	337 338	91402 377020
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985	1916	1347	376015	424.500000	0	337	377551
986	1830	1143	388479	0.00000	0	337	389748
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991	1454	1285	394280	569.000000	0	336	394523
992	1609	1327	394347	0.000000	0	336	394601
993	1198	1220	394451	0.000000	0	335	394690
994	1063	1124	394532	0.000000	0	334	394769
995 996	1726 1222	1178 1307	394606 394714	0.000000	0	334 334	394857 394974
997	1403	1272	394714	0.000000	0	334	395060
998	2164	1335	394777	532.333333	0	334	395056
999	1229	1344	394907	0.000000	0	336	395185
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1002	1389	1222	392975	0.000000	0	337	393730
1003	1288	1287	392828	490.333333	0	337	393648
1004	1377	1258	394892	449.000000	0	337	395344
1005	1089	1176	371312	400.000000	0	338	373179
1006	1089	1207	369610	298.000000	0	338	370202
1007	1132	1252	367034	0.000000	1	338	369376
1008 1009	1066 1031	1133 1194	366199 365574	467.500000	1 1	338 338	368415 367673
1010	1331	1295	365041	0.000000	1	338	366754
1011	957	1254	374382	0.000000	1	340	376394
1012	1021	1243	139948	0.000000	1	340	159312
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	, 5 0				v		

1037	782	932	256804	518.000000	11	342	256953
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1056	680	904	79983	0.000000	3	348	81414
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1061	887	1216	272007	0.00000	3	348	273396
1062	852	1252	269272	0.000000	3	348	270475
1063	743	1091	171768	705.500000	1	348	146495
1064	607	1105	135110	684.000000	2	347	136226
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1070	606 796	1717 1594	132302 130351	544.000000	12 14	341 341	133853 131985
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1072	636	1632	152541	333.000000	9	344	161286
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1079	38108	3427	144610	453.500000	10	345	160399
1080	37158	3123	136486	393.000000	7	348	147009
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1082	34945	2754	140789	511.000000	7	350	156182
1083	37892	2650	136205	0.000000	4	350	152013
1084	39777	2640	137048	0.000000	0	351	153117
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1086	16500	2237	138363	478.500000	0	351	155280
1087 1088	39037 72896	1671 2561	74974 133509	0.000000	0	351 351	86951 148445
1089	80209	2436	131246	678.500000	0	352	149303
1009	102071	2615	137594	545.500000	0	352	149303
1091	127266	1503	128995	478.666667	0	354	144237
1092	119897	1513	131142	395.000000	0	354	146172
1093	105879	2463	127286	407.400000	0	355	142567
1094	120036	1914	131724	386.000000	0	357	146274
1095	104580	1653	129964	0.000000	0	359	142071
1096	77515	1845	126700	392.666667	0	359	139067
1097	65102	1906	128650	0.000000	1	359	141048
1098	67692	1986	123625	284.000000	1	359	136816
1099	55163	1952	126834	484.000000	1	358	139761
1100	48530	2239	128868	448.000000	1	357	141862
1101	47694	2245	125037	371.000000	1	357	141271
1102	39608	1718	121657	349.000000	1	357	140935

1103	52361	1532	210626	0.000000	1	357	200335
1104	17397	1428	207869	490.000000	0	358	197464
1105	2577	1313	215188	356.000000	0	357	212084
1106	1550	1351	216360	363.200000	2	358	211717
1107	1940	1382	214338	0.00000	3	356	204617
1108	1825	1388	213310	526.000000	3	356	213465
1109	1862	1343	218547	341.600000	5	356	202373
1110	2072	1268	223983	325.000000	10	354	206637
1111	1694	1374	225413	0.000000	10	355	205982
1112	4686	1302	227835	679.000000	10	355	236828
1113	6209	1243	247239	405.500000	8	355	244274
1114	8820	1480	249043	372.500000	8	356	239129
1115	8500	1399	252074 202575	0.000000	7 5	357	256071 216693
1116 1117	4092 1332	1299 1223	202373	0.000000	1	356 357	215754
1118	1281	1159	204089	409.500000	1	357	218364
1119	1160	1109	203267	0.000000	1	358	213418
1120	11235	1220	202685	374.000000	0	357	213428
1121	12779	2297	214882	0.00000	0	356	223061
1122	13107	2339	213361	0.00000	0	356	221820
1123	10408	2095	212867	338.000000	0	356	221742
1124	11142	1821	208083	0.00000	0	356	217384
1125	8936	1668	205480	0.00000	0	356	215695
1126	4375	1547	204942	0.00000	0	356	215519
1127	1619	1534	206213	723.000000	0	356	216698
1128	2031	1445	206925	0.00000	0	355	217314
1129	2086	1252	202998	456.000000	0	355	210101
1130	2106	1226	201336	307.000000	0	355	208523
1131	2374	1279	202520	0.000000	0	354	213401
1132	1977	1175	206397	0.000000	0	353 354	217183
1133 1134	1743 1715	1145 1327	209917 206312	0.000000	0	354	221719 218000
1135	1523	3556	205545	586.000000	0	354	213308
1136	1447	3341	200304	620.000000	0	354	208799
1137	1675	2754	196062	567.000000	0	354	205583
1138	1880	2463	193449	656.000000	0	355	206939
1139	2356	2507	198829	470.000000	0	355	208047
1140	2255	2265	199593	0.00000	0	355	208852
1141	1589	2150	196498	0.00000	0	355	206458
1142	1824	2106	192456	568.000000	0	355	203043
1143	1939	1784	196850	583.000000	0	355	206785
1144	2772	1627	196593	455.000000	0	355	206641
1145	3966	1579	106171	531.250000	0	359	119038
1146	2124	1500	196080	353.600000	0	359	205839
1147	1766	1449	198032	571.500000	1	359	211118
1148 1149	1525 1574	1298 1361	191821 191425	0.000000 560.500000	1 1	359 359	205129 201896
1149	2228	1326	191423	415.750000	1	359	201696
1151	2409	1311	191748	424.000000	8	359	202477
1152	2775	1284	193442	462.500000	8	359	203946
1153	3098	1216	195785	0.00000	8	359	205524
1154	3442	1176	198361	428.000000	7	360	211446
1155	2716	1187	197539	522.000000	7	360	214899
1156	2340	1968	194216	473.500000	7	361	214339
1157	2354	2038	193181	0.00000	7	361	213470
1158	2444	1727	193933	524.000000	0	361	209600
1159	3069	1655	195556	0.000000	0	362	211529
1160	3622	1565	186517	0.000000	0	363	206082
1161	2218	1496	179335	0.000000	0	363	200023
1162	2227	1400	184140	599.500000	0	363	204068
1163 1164	2635 2485	1208 1176	183054 198804	389.000000	0 3	363 364	203282 218310
1164	3054	1176	198804	531.500000	3	365	218310
1166	7048	1105	194313	512.666667	5 5	365	214971
1167	5593	1124	201418	386.166667	5	365	220296
1168	4286	1090	205633	0.000000	5	366	224171

1169	6992	1075	208727	578.666667	5	366	226775
1170	8327	1266	208636	403.000000	5	367	226672
1171	7454	1225	196470	0.00000	2	367	216215
1172	10488	1125	203680	0.000000	2	366	222188
1173	10503	1161	197581	0.000000	0	367	217078
1174	13900	1066	196171	0.000000	0	367	215880
1175	13995	1063	195006	0.000000	0	368	213605
1176	9447	1143	197290	0.000000	0	367	215599
1177	9447	1327	197707	0.000000	0	367	216407
1178	6464	1204	194372	0.000000	0	367	214011
1179	5958	1195	193151	0.000000	0	366	213490
1180 1181	4375 2728	1100 1064	207535 208233	505.000000 416.500000	0	366 366	226366 226834
1182	1727	1213	199393	0.000000	1	367	219295
1183	1532	1168	202501	0.000000	1	368	222335
1184	1660	2864	198891	0.000000	1	367	219410
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1186	1592	2516	193603	0.000000	1	367	215172
1187	1489	2230	191422	0.000000	6	367	213120
1188	1546	2175	178585	0.000000	6	367	200714
1189	1436	2032	176328	0.000000	5	367	198909
1190	1401	1918	173750	0.000000	5	367	196521
1191	1314	1373	182049	315.750000	5	367	203594
1192	1540	1128	180046	0.000000	5	367	201658
1193	1357	1098	178864	487.333333	5	367	200640
1194 1195	1521 1513	1063 1057	179979 179326	387.500000	0	366 366	201731 201045
1196	1297	992	180194	0.000000	0	367	201043
1197	1141	1038	188933	0.000000	0	367	211050
1198	1353	1074	186785	0.000000	0	367	209433
1199	1204	1041	184783	418.000000	0	367	208131
1200	1185	1068	182659	0.000000	1	367	207083
1201	1336	1019	185255	0.000000	1	367	209219
1202	1334	1028	188019	0.000000	1	368	211647
1203	1093	1131	189455	0.000000	1	368	212742
1204	1047	1065	188008	0.00000	1	367	211463
1205	1028	1240	185769	0.000000	1	367	209366
1206	1187	1223	182183	519.000000	0	367	206069
1207 1208	1148 1049	1072 1181	184224 188417	0.000000 379.000000	0	367 367	207421 210772
1208	1204	1088	167429	767.000000	0	367	191301
1210	1172	1077	167371	0.000000	0	366	191400
1211	936	946	171055	0.000000	0	366	194453
1212	1104	1083	170906	0.00000	0	366	194640
1213	1170	1097	170680	0.000000	0	366	194550
1214	965	1225	183220	585.000000	0	366	206789
1215	1134	1187	185749	0.000000	0	366	209485
1216	1010	1213	195792	333.666667	0	366	218675
1217	924	1176	193640	0.000000	0	366	217194
1218	879	1185	190217	0.000000	0	365	214396
1219	1102	1262	188106	0.000000	0	365 365	212330
1220 1221	1051 1064	1244 1192	192868 191441	0.000000	0	366	216490 214965
1222	1280	1127	188660	0.000000	0	366	212279
1223	1270	1124	186542	0.000000	0	366	211061
1224	948	1089	192326	0.000000	0	366	215632
1225	912	1192	176393	0.000000	0	366	200355
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1227	1046	1421	180723	0.000000	0	366	203865
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1229	1209	1471	176690	0.000000	1	365	200426
1230	1223	1359	172898	0.000000	2	366	196684
1231	900	1268	176476	0.000000	2	366	199554
1232 1233	792 1085	1250	195542 184383	0.000000 628.000000	2	367 366	217194
1233	1085 1106	1325 1321	184383	0.000000	0	366 368	208283 209004
1404	T T O O	1 J Z I	107701	0.00000	U	200	203004

1235	1406	1387	186172	0.000000	1	368	209553
1236	1081	1344	179959	0.000000	2	368	203856
1237	1125	1322	184686	0.00000	4	369	207904
1238	739	1164	176942	0.000000	4	369	201215
1239	770	1238	179493	0.00000	4	368	203810
1240	885	1129	179679	0.000000	4	368	203713
1241	1004	1146	179606	0.000000	4	370	203351
1242	984	1236	183315	0.000000	4	370	206703
1243	880	1195	163769	0.000000	0	370	188628
1244 1245	811 609	1334	163972	0.000000	0	370 370	188083 186669
1245	544	1194 1153	163364 165714	0.000000	0	370	188744
1247	688	1819	164531	0.000000	0	370	187582
1248	852	1672	70581	0.000000	0	370	88448
1249	632	1726	68621	496.000000	0	370	83620
1250	753	1666	93105	0.000000	0	370	109935
1251	795	1684	95780	524.000000	0	370	112442
1252	808	1543	84317	0.000000	0	370	102075
1253	598	1540	85672	0.000000	0	370	102921
1254	739	1706	178674	0.000000	0	370	200873
1255	889	1669	175569	0.000000	0	369	198229
1256 1257	900	1676	174595	0.000000	0	368 367	197171
1257	851 942	1608 1501	177983 172809	0.000000	0	368	199986 195333
1259	716	1550	170240	0.000000	0	368	192329
1260	718	1484	156524	0.000000	0	368	178840
1261	674	2167	158883	0.000000	0	367	180989
1262	734	2062	160917	0.000000	0	367	182756
1263	650	1947	161596	0.000000	0	367	183014
1264	720	1886	155106	0.00000	0	367	178234
1265	690	1912	159061	0.000000	0	367	181421
1266	590	1858	154096	0.00000	0	368	177380
1267	513	1735	154098	0.000000	0	368	177339
1268	964	1784	169973	0.000000	0	367	193002
1269 1270	948 773	1591 1580	90094 91363	0.000000	0	366 366	106612 108366
1270	830	1520	87277	0.000000	0	367	104554
1272	738	1502	86850	243.500000	0	367	103855
1273	728	1440	76326	226.000000	0	367	93772
1274	883	1388	77747	0.000000	0	367	95009
1275	883	1812	80237	0.000000	0	367	97949
1276	817	1681	160527	0.000000	0	368	180884
1277	856	1651	154773	524.000000	0	368	175905
1278	861	1783	142524	578.000000	0	366	164592
1279	846	1648	152527	327.000000	0	366	173068
1280 1281	629 552	1480 1428	152973 157836	426.000000	0	366 366	173101 177303
1282	797	1413	157030	0.000000	0	366	177454
1283	2783	1404	153240	0.000000	0	366	173565
1284	3561	1456	159900	0.000000	0	366	182754
1285	2584	1509	157000	338.000000	0	367	180826
1286	920	1414	157231	0.00000	0	367	179706
1287	806	1402	149995	0.000000	0	367	174156
1288	613	1269	165640	0.00000	0	367	190712
1289	856	1371	167088	0.000000	0	367	192152
1290	972	1436	160550	0.000000	0	367	187333
1291 1292	818 699	1360 1430	158182 161890	0.000000 286.500000	0	366 366	190443 193309
1292	868	1501	164682	0.000000	0	366	196097
1294	984	1498	164845	301.666667	0	367	195957
1295	1193	1560	166158	231.500000	0	367	197279
1296	1207	1752	147652	0.000000	0	367	177915
1297	1025	1705	148909	0.00000	0	367	179348
1298	1098	1745	146850	0.00000	0	367	177138
1299	984	1579	150009	0.000000	0	367	178997
1300	1434	1566	144635	0.00000	0	367	174217

1301	2150	1658	145801	0.000000	0	367	174965
1302	1831	1567	144494	0.000000	0	367	173293
1303	2056	2259	146153	0.000000	0	367	175380
1304	1954	2221	145220	0.000000	0	367	174476
1305	2037	2035	144031	0.00000	3	367	173381
1306	2082	2052	147408	445.666667	0	368	175850
1307	2095	2023	148046	0.00000	3	368	176578
1308	1044	1925	147921	0.000000	3	368	176678
1309	590	1668	163246	0.000000	3	367	192698
1310	725	2001	164039	0.000000	3	367	193488
1311	743	1789	164348	376.250000	13	368	193759
1312	1159	1783	161081	0.000000	11	370	190975
1313	1081	1814	160728	465.000000	12	370	190149
1314	877 760	1859 1755	145553	402.000000	16	371	174517
1315 1316	759	1926	140862 157238	0.000000 612.000000	16 16	372 372	170358 187196
1317	901	2937	137236	515.000000	15	373	167402
1318	933	3254	135038	0.000000	5	373	164676
1319	850	2792	137122	0.000000	5	373	166167
1320	870	2840	138403	0.000000	0	374	166467
1321	786	3380	141684	412.000000	0	374	168679
1322	672	3657	140256	367.666667	0	375	167178
1323	588	3414	136841	0.00000	0	375	163913
1324	594	3487	137575	0.00000	0	375	164482
1325	678	3448	135642	0.00000	0	376	162632
1326	754	3231	129767	360.000000	0	377	157028
1327	687	3324	141365	0.000000	0	378	170130
1328	619	3429	139969	0.00000	0	379	168785
1329	657	2700	135621	0.000000	0	380	164893
1330	611	3301	132797	0.000000	0	381	161959
1331	655 723	4137	131006	291.500000	2	381	160044
1332 1333	752	4513 4782	128797 117195	0.000000	2	381 381	157601 143391
1334	721	4571	116277	0.000000	2	381	142352
1335	820	4360	114926	559.000000	2	382	140372
1336	48	39	379454	186.250000	0	226	465864
1337	78	69	404875	168.500000	0	226	487377
1338	50	38	407748	164.666667	0	227	494572
1339	37	21	413262	179.000000	0	227	498931
1340	63	54	411552	180.666667	0	227	497810
1341	37	28	415817	225.250000	0	227	501227
1342	38	33	414664	190.000000	0	226	500469
1343	38	26	414341	180.000000	0	226	500399
1344	20	12	413918	207.666667	0	226	500335
1345	40	35	415214	169.000000	0	227	501318
1346	222	201	413591	0.000000	0	226	500659
1347 1348	178 61	175 30	408760 399549	171.500000	0	226 226	496706 484701
1349	16	15	399135	193.285714	0	226	484657
1350	19	18	406383	161.666667	0	225	488540
1351	23	20	417056	148.333333	0	225	494006
1352	44	41	418699	148.600000	0	225	494503
1353	15	14	426139	123.000000	0	225	498981
1354	17	16	429750	0.00000	0	225	501102
1355	16	10	438659	0.00000	0	225	507319
1356	69	60	445913	160.222222	0	225	511525
1357	80	55	448515	105.500000	0	225	512635
1358	121	98	452730	127.000000	0	226	514821
1359	78	68	341602	0.000000	0	225	382407
1360	45	33	343616	0.000000	0	226	384935
1361	49	39	333774	138.000000	0	226	374229
1362	54 53	37 28	322209	146.000000	0	227	366514
1363 1364	53 34	28 29	312061 324869	178.200000 162.800000	0	227 227	362294 371120
1365	122	38	282651	160.600000	0	227	334575
1366	81	25	285552	196.571429	0	227	336553
-500	3 1	2 9	_ 5 5 5 5 2	1000011120	9		55555

1368	1367	77	63	290998	165.909091	2	227	341518
1369 56 47 28897 218.666667 3 227 332444 1371 39 27 296078 168.750000 3 228 341988 1372 33 27 299220 177.833333 3 228 345197 1373 30 26 448821 168.3333333 3 228 522166 1375 27 25 481960 165.000000 0 227 547701 1376 20 18 505548 189.050000 0 227 547701 1377 35 20 599644 0.000000 0 226 594268 1380 35 34 555210 162.00000 0 226 594268 1381 40 31 55120 162.00000 0 226 595743 1381 40 351260 10.00000 0 226 598751 1381 33 23 538266								
1370 36 27 288997 218.666667 3 228 341988 1371 39 27 299020 177.833333 3 228 341988 1373 30 26 448821 168.333333 3 227 502606 1375 27 25 481960 165.000000 0 229 530635 1376 20 18 505548 139.750000 0 227 572423 1377 35 20 539644 0.000000 0 227 572423 1378 20 18 547905 165.800000 0 226 57803 1380 35 34 555210 162.000000 0 226 598751 1381 40 31 551205 0.000000 0 226 598746 1384 40 36 555641 174.250000 0 226 594567 1385 31 23								
1371 39 27 299078 168.750000 3 228 345197 1373 30 26 448821 168.333333 3 228 522166 1374 59 23 47226 159.333333 3 228 522166 1375 27 25 481960 165.000000 0 227 547701 1376 20 188 505548 139.750000 0 227 547701 1377 35 20 559644 0.000000 0 226 578003 1378 33 27 562240 162.000000 0 226 598751 1381 40 31 551205 0.000000 0 226 598751 1382 52 42 559018 211.750000 0 226 598751 1384 40 36 555634 174.250000 0 226 588101 1385 31 23			27					
1373 30 26 44821 168.333333 3 227 50206 1374 59 23 472256 159.333333 3 228 522166 1375 27 25 481960 165.000000 0 227 547701 1377 35 20 539644 0.000000 0 226 57423 1378 20 18 547905 165.800000 0 226 578003 1379 33 27 562240 162.000000 0 226 589751 1381 40 31 555210 10.00000 0 226 588751 1383 58 49 554701 164.40000 0 226 592746 1384 40 36 555634 174.250000 0 226 594567 1385 31 23 538266 170.500000 2 226 5886751 1386 15 9546391	1371	39	27	296078	168.750000	3		341988
1374 59 23 472256 159.333333 0 228 520166 1376 20 18 505548 159.00000 0 227 547701 1377 35 20 539644 0.000000 0 226 572423 1378 20 18 547905 165.800000 0 226 5994268 1380 35 34 555210 142.666667 0 226 599746 1381 40 31 551205 0.000000 0 226 599743 1382 52 42 559018 211.750000 0 226 599746 1384 40 36 555634 174.250000 0 226 594567 1384 40 36 555634 174.250000 0 226 594567 1385 31 23 538266 170.50000 2 226 598761 1386 15 946391	1372	33	27	299220	177.833333	3	228	345197
1375 27 25 481960 165.00000 0 227 547701 1377 35 20 158644 0.000000 0 227 572423 1378 20 18 547905 165.800000 0 226 578003 1379 33 27 562240 162.000000 0 226 594268 1380 35 34 555210 142.666667 0 226 589103 1381 40 31 551205 0.000000 0 226 589743 1383 58 49 554701 164.400000 0 226 595746 1384 40 36 555634 174.250000 0 226 580613 1385 31 23 538266 170.50000 2 226 580616 1386 15 9 546391 139.00000 2 225 584661 1387 18 17 <td< td=""><td>1373</td><td>30</td><td>26</td><td>448821</td><td></td><td>3</td><td>227</td><td>502606</td></td<>	1373	30	26	448821		3	227	502606
1376 20 18 505548 139.750000 0 227 547701 1377 35 20 539644 0.000000 0 226 578003 1379 33 27 562240 162.000000 0 226 578003 1380 35 34 555210 142.666667 0 225 588751 1381 40 31 551205 0.000000 0 226 598743 1383 58 49 554701 164.400000 0 226 598743 1384 40 36 555634 174.250000 0 226 594567 1385 31 23 538266 170.50000 2 226 588651 1386 15 9 546391 139.00000 2 226 588651 1387 18 17 533556 198.00000 2 225 599120 1388 52 48 <td< td=""><td></td><td></td><td></td><td>472256</td><td></td><td>0</td><td></td><td>522166</td></td<>				472256		0		522166
1377 35 20 539644 0.000000 0 226 578003 1379 33 27 562240 162.000000 0 226 594268 1380 35 34 555210 142.666667 0 225 589751 1381 40 31 555105 0.000000 0 226 589743 1383 58 49 554701 164.400000 0 226 595744 1384 40 36 555634 174.250000 0 226 594661 1385 31 23 538266 170.500000 2 226 5881013 1386 15 9 546391 139.000000 2 226 5881013 1387 18 17 533536 188.000000 2 225 5884651 1388 52 48 541360 0.000000 2 225 5848674 1389 44 39								
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1486 347 228 410436 311.3333333 1 271 426634 1487 346 224 412520 261.000000 3 271 425788 1488 425 293 410440 0.000000 3 272 425318 1489 439 283 428508 283.000000 3 272 440638 1490 372 256 429377 304.000000 3 272 440474 1491 393 251 428296 368.333333 3 272 443558 1492 346 252 428448 221.000000 2 273 443646 1493 405 206 429076 0.000000 2 273 443646 1494 377 235 468058 280.000000 0 274 468464 1496 301 191 483726 297.250000 0 274 482386 1497 362 201 483667 267.000000 0 276 482486	1484	424	272	418538	0.00000	0	271	424274
1487 346 224 412520 261.000000 3 271 425788 1488 425 293 410440 0.000000 3 272 425318 1489 439 283 428508 283.000000 3 272 440638 1490 372 256 429377 304.000000 3 272 440474 1491 393 251 428296 368.333333 3 272 443558 1492 346 252 428448 221.000000 2 273 443859 1493 405 206 429076 0.000000 2 273 443646 1494 377 235 468058 280.000000 0 273 470433 1495 289 184 460322 0.000000 0 274 468464 1496 301 191 483726 297.250000 0 274 482386 1497 362 201 483667 267.000000 0 276 482486	1485	434	266	426097	0.00000	1	271	429792
1488 425 293 410440 0.000000 3 272 425318 1489 439 283 428508 283.000000 3 272 440638 1490 372 256 429377 304.000000 3 272 440474 1491 393 251 428296 368.333333 3 272 443558 1492 346 252 428448 221.000000 2 273 443859 1493 405 206 429076 0.000000 2 273 443646 1494 377 235 468058 280.000000 0 273 470433 1495 289 184 460322 0.000000 0 274 468464 1496 301 191 483726 297.250000 0 274 482386 1497 362 201 483667 267.000000 0 276 482486								
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1499	341	199	482615	326.000000	0	278	481650
1500	371	239	450708	316.000000	0	278	446642
1501	349	247	492936	359.666667	1	280	491073
1502	1456	1007	489948	276.000000	1	279	489249
1503	1462	1056	434017	271.000000	2	279	435777
1504	1183	810	391444	241.250000	2	280	402606
1505	1047	724	359109	0.000000	2	279	379892
1506	963	657	341031	243.800000	4	279	366392
1507	881	645	341960	209.000000	12	279	367293
1508	941	651	342191	0.000000	12	279	367981
1509	447	289	320266	246.000000	12	279	348232
1510 1511	341 321	217 185	322116 298233	266.800000	12 12	279 279	349562 329730
1512	377	234	307554	283.000000	4	279	336751
1513	357	224	306545	274.000000	4	279	335365
1514	330	197	302433	0.000000	4	279	332512
1515	311	189	318140	277.000000	4	279	346529
1516	392	284	344569	0.000000	19	279	370574
1517	522	362	346617	326.500000	19	280	371511
1518	453	317	363454	297.750000	19	280	381413
1519	408	282	351333	239.000000	19	280	377496
1520	670	373	300267	209.666667	19	281	325742
1521	613	387	246090	304.000000	19	281	277955
1522	718	387	210302	299.000000	11	282	243481
1523 1524	830 525	367 279	176641 177477	406.500000 332.222222	11 11	282 283	208842 210718
1525	640	303	177484	317.125000	11	284	210718
1526	645	296	153947	295.500000	11	284	184902
1527	591	290	146085	401.000000	11	285	174231
1528	481	272	144346	362.000000	11	286	172816
1529	613	296	146917	366.333333	11	286	175702
1530	852	549	138904	274.000000	11	287	167285
1531	870	547	134556	282.000000	11	288	161989
1532	787	486	130237	295.600000	11	289	157344
1533	757	452	131819	289.400000	11	289	159573
1534	1054	678	126596	247.333333	11	290	153081
1535 1536	927 839	588 504	135085 104512	322.000000 335.800000	11 11	291 291	161660
1537	1180	642	104312	340.800000	11	291	127138 130204
1538	5450	1421	109977	321.250000	11	293	134714
1539	5651	1483	116828	349.571429	11	293	141243
1540	5687	1510	217453	342.714286	11	294	219782
1541	5706	1548	83294	392.000000	12	295	84028
1542	5314	1522	168118	327.875000	12	300	169789
1543	4586	1368	156445	334.333333	14	301	158675
1544	4125	1446	153901	608.000000	14	300	156071
1545	3453	1355	81179	335.600000	14	299	82756
1546	3325	1325	80903	288.666667	6	298	82616
1547 1548	3206 2900	1360 1366	72195 72189	355.250000 317.500000	6 6	298 300	75459 75488
1549	2814	1263	67869	512.500000	5	301	71181
1550	2505	1161	67557	476.777778	2	301	70805
1551	2750	1143	67827	421.000000	3	300	71125
1552	2743	1154	73344	365.000000	3	302	76556
1553	2242	1121	72847	0.000000	7	300	76133
1554	2130	1099	78202	402.500000	7	302	80852
1555	2172	1084	80717	0.000000	7	303	82991
1556	2125	1035	83704	393.333333	7	304	84969
1557	1957	1026	83581	356.000000	10	304	84899
1558	3791	2147	100334	355.000000	9	304	101265
1559	3893	2317	83775	0.000000	9	305	85045
1560 1561	3796 3518	2064 1940	84469 84318	451.000000 346.333333	9 8	305 306	85410 85348
1562	3482	1940	84332	0.000000	8	306	85392
1563	3411	1877	84334	370.000000	8	306	85405
1564	3092	1731	84448	0.000000	4	306	85519
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1565	2307	1207	84485	359.000000	5	305	85603
1566	2253	1081	84623	0.000000	2	305	85684
1567	2167	1093	84594	300.000000	2	307	85662
1568	2203	1101	84559	0.00000	2	309	85688
1569	2295	1139	84647	338.666667	2	310	85764
1570	2646	1122	84562	451.500000	2	310	85692
1571	2154	1032	84472	361.000000	2	311	85676
1572	3984	2544	84721	317.000000	2	312	85838
1573	4284	2570	84769	301.000000	2	312	85867
1574	4099	2289	83840	378.000000	2	312	85403
1575	4031	2235	84668	295.666667	2	313	85884
1576 1577	3990 4078	2255 2298	84659 84581	305.600000 243.000000	5 6	314 316	85885 85830
1578	3663	2028	84597	389.000000	6	316	85852
1579	3289	1624	81765	0.000000	4	315	83779
1580	3441	1512	82769	593.000000	7	318	84434
1581	3245	1547	82132	348.750000	8	318	84115
1582	3102	1523	86016	372.000000	11	318	86785
1583	2987	1553	83756	369.000000	9	317	85547
1584	2860	1373	80396	389.000000	13	318	82960
1585	2662	1254	79956	351.000000	13	319	82590
1586	2363	1373	79071	0.000000	13	318	81831
1587	2279	1350	80134	429.500000	9	321	82787
1588	2356	1356	79797	418.000000	6	321	82410
1589	2034	1299	74877	270.600000	6	321	90182
1590	2240	1289	79293	0.000000	0	322	93858
1591 1592	2244	1195 1150	68613 64688	412.000000 430.000000	0	322 322	82709
1592	2142 2053	1226	69767	0.000000	0	321	79075 83645
1594	1911	1230	74374	492.000000	5	321	88270
1595	2094	1217	72278	360.000000	8	321	85491
1596	1883	1150	67766	278.000000	9	321	81554
1597	2292	1230	72594	300.000000	9	321	86682
1598	2065	1288	77077	0.00000	9	321	90728
1599	2329	1246	78359	0.00000	9	323	91986
1600	2688	1413	77416	0.00000	9	324	91402
1601	2577	1451	79071	0.000000	3	324	92734
1602	2564	1425	77361	0.00000	0	324	91465
1603	2599	1337	75410	0.000000	0	325	90048
1604	2536	1387	45644	0.000000	0	326	57869
1605	2537 2301	1436 1301	51472	0.000000	3	326	63678 60840
1606 1607	2574	1352	48379 73087	441.000000	3	326 326	86798
1608	2353	1263	71852	439.000000	3	326	85545
1609	2862	1304	74298	395.000000	3	325	87662
1610	2544	1276	74700	400.333333	5	327	88098
1611	2254	1349	80506	0.00000	5	327	93917
1612	2509	1333	56367	347.333333	2	327	68739
1613	2355	1298	53648	0.00000	4	327	66156
1614	4837	3294	54734	323.666667	4	327	67437
1615	5478	3435	474438	402.500000	4	327	474638
1616	4731	2913	86078	387.500000	4	326	99358
1617	4066	2652	85292	365.000000	4	327	98254
1618	4127	2538	79047	620.000000	4	327	92475
1619 1620	4212 4001	2540 2464	81394 74827	566.500000 486.000000	4 2	329 329	94672 88902
1621	5543	3783	146415	0.000000	5	329	155077
1622	5294	3454	489974	565.000000	11	327	490071
1623	4967	3169	390456	419.500000	14	327	390707
1624	4632	3002	390393	359.000000	12	328	390729
1625	4594	2870	454868	0.000000	12	328	455351
1626	4571	2772	455749	0.000000	12	327	455789
1627	4498	2724	443108	0.000000	12	326	444004
1628	3283	1929	444982	471.000000	9	327	445170
1629	2700	1611	442715	452.666667	1	328	443624
1630	2808	1535	436807	0.000000	0	328	437346

1632 2471 1307 406252 0.000000 1 329 406498 1633 2739 1426 137501 595.000000 1 328 405896 1635 3437 2175 405649 341.000000 1 328 405896 1635 3437 2175 405649 341.000000 3 328 392593 1636 3974 2244 391967 0.000000 3 328 392593 1638 3684 1884 389303 0.000000 2 332 389571 3638 3684 1884 389303 0.000000 2 332 389571 3638 3684 1884 389303 0.000000 2 332 389571 3638 3684 1884 389303 0.000000 2 332 388671 3640 2838 1613 92886 0.000000 2 333 93893 3641 3428 3449	1631	2478	1477	410615	0.000000	0	329	407557
1633 2739 1426 137501 595,000000 1 328 405896 1635 3437 2175 405649 341,000000 1 328 405896 1636 3974 2244 391967 0.000000 3 328 392593 1638 3684 1884 389303 0.000000 2 322 392879 1639 2900 1751 131185 336,500000 2 332 182806 1640 2963 1716 87725 0.000000 2 333 93893 1641 3091 1795 39311 465,000000 2 333 93893 1642 2381 1443 39130 406,000000 0 335 106344 1645 2355 1447 105800 0.000000 0 335 105617 1648 2074 1276 90883 49,500000 0 335 91376 1648 2074 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
1634 2298 1413 405389 561.000000 1 328 405237 1635 3974 2244 391967 0.000000 3 328 392593 1637 3744 2004 392317 432.000000 3 328 392593 1638 3884 1884 389303 0.000000 2 332 389671 1640 2963 1716 87725 0.000000 2 332 389671 1641 3091 1795 93311 465.000000 2 333 94942 1642 2838 1613 92886 0.000000 2 333 93893 1643 2345 1443 90139 399.00000 335 105617 1644 2346 1493 106190 0.00000 0 335 105617 1644 2349 1404 90598 0.000000 0 335 105617 1648 2074 1276								
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1638	1636	3974	2244	391967	0.000000	3	328	392593
1639	1637	3744	2004	392317	432.000000	3	328	392979
1640		3684						
1641 3091 1795 93311 465.000000 2 333 94242 1642 2838 1613 92886 0.000000 0 334 94087 1644 2346 1493 106199 389.000000 0 335 106344 1645 2353 1447 105800 0.000000 0 335 106344 1646 2298 1883 104196 0.000000 0 335 105128 1647 2249 1404 90598 0.000000 0 335 91376 1648 2074 1276 90853 449.500000 0 335 91376 1649 2130 1417 90654 508.000000 0 335 91376 1659 2039 1283 376423 384.000000 0 337 379854 1651 2064 1291 379606 0.000000 0 337 379854 1652 2045 1304 379950 418.000000 0 337 377551 1653 2046 1347 376015 424.500000 0 337 377551 1654 1790 1143 388479 0.000000 0 337 389148 1655 1918 1169 386878 425.00000 0 337 389148 1655 1918 1169 386878 425.00000 0 337 391892 1658 2152 1262 390109 424.00000 0 336 390812 1659 2458 1285 394280 569.00000 0 336 394523 1660 2325 1327 394347 0.000000 0 336 394523 1661 2406 1220 394451 0.000000 0 334 394764 1663 2027 1178 394606 0.000000 0 334 394764 1664 2274 1307 394134 0.000000 0 334 394857 1666 2226 1335 394777 532.33333 0 337 395185 1670 1868 1223 39480 653.500000 0 337 395185 1671 2073 1287 39288 490.333333 0 337 395344 1673 1917 1176 371312 400.00000 0 338 373179 1676 1742 1133 366199 477.500000 1 340 376394 1677 1948 1149 366574 0.000000 1 340 376394 1678 2013 1247 135604 0.000000 1 340 376394 1681 1994 1247 135604 0.000000 1 340 376394 1682 2044 1266 479620 418.000000 3 340 366754 1683 1694 1247 135604 0.000000 3 340 366754 1686 2052 1294 365574 0.000000 3 340 366558 1687 2044 1266 479620 418.000000 3								
1642 2838 1613 92886 0.000000 2 333 93893 1643 2436 1443 106199 389.000000 0 335 106344 1645 2353 1447 105800 0.000000 0 335 105617 1646 2298 1838 104196 0.000000 0 335 105617 1647 2249 1404 90598 0.000000 0 335 91589 1649 2130 1417 90654 588.000000 0 335 91589 1650 2039 1283 376423 384.000000 0 337 379554 1651 2045 1304 379950 418.000000 0 337 377551 1654 1780 1143 388479 0.000000 0 337 388174 1655 1918 1169 386784 425.000000 0 337 388175 1655 1921 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
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1697	1780	1152	256330	0.000000	1	338	256463
1698	1707	1072	256400	531.333333	1	338	256541
1699	1413	952	256523	425.000000	0	339	256674
1700	1255	855	256757	423.000000	4	341	256907
1701	1426	924	256768	391.500000	6	340	256868
1702	1366	879	256507	398.000000	6	341	256612
1703	1421	955	256747	0.00000	6	341	256848
1704	1211	879	256915	0.000000	6	343	256974
1705	1324	932	256804	518.000000	11	342	256953
1706	1325	931	251280	471.333333	11	342	251477
1707	1473	1064	248548	371.000000	5	344	248742
1708	1440	1006	125536	0.000000	5	345	126702
1709 1710	1314 1341	905 873	211712 192846	0.000000	5 5	344 344	212943 194268
1711	1207	792	192546	367.000000	5	344	194200
1712	1566	1080	207119	620.000000	0	345	208547
1713	1671	1153	204629	0.000000	0	344	206141
1714	1547	1047	197569	542.000000	0	343	198671
1715	1691	1127	203459	613.000000	1	343	204867
1716	1722	1046	126430	386.500000	4	345	127226
1717	1453	937	273698	297.500000	4	345	274046
1718	1298	862	273031	0.00000	4	345	273451
1719	1547	1003	278761	501.000000	4	346	279410
1720	1487	956	156151	567.000000	4	346	166819
1721	1299	861	110515	565.333333	4	346	111887
1722	1481	925	79881	461.000000	3	346	81606
1723	1365	969	80435	0.000000	1	346	81771
1724	1302	904	79983	0.000000	3	348	81414
1725	1242	859	271420	0.000000	3	348	272709
1726	1736	1178	270655	0.000000	3	348	272020
1727 1728	1855 1719	1168 1122	275886 83187	337.500000	3	348 348	276341 84374
1729	1767	1216	272007	0.000000	3	348	273396
1730	1721	1252	269272	0.000000	3	348	270475
1731	1500	1091	171768	705.500000	1	348	146495
1732	1567	1105	135110	684.000000	2	347	136226
1733	3129	2275	132527	440.500000	2	345	133685
1734	3373	2246	104630	381.500000	10	342	105796
1735	3094	1971	115840	411.333333	12	342	116954
1736	2776	1886	105027	376.600000	13	342	105770
1737	2814	1844	133189	345.500000	12	341	134800
1738	2630	1717	132302	0.000000	12	341	133853
1739	2517	1594	130351	544.000000	14	341	131985
1740	2595	1841	150495	389.500000	14	344	162668
1741	2351	1632	152541	333.000000	9	344	161286
1742 1743	2232 2132	1551 1447	154716 93046	573.500000 484.666667	8 7	344 344	169757 93927
1743	2757	1648	81542	414.375000	10	345	82472
1745	2600	1598	148644	321.000000	13	346	164471
1746	3229	2015	143247	418.000000	10	346	160029
1747	10019	3427	144610	453.500000	10	345	160399
1748	6035	3123	136486	393.000000	7	348	147009
1749	6585	2888	143148	592.000000	7	349	158677
1750	6284	2754	140789	511.000000	7	350	156182
1751	6405	2650	136205	0.000000	4	350	152013
1752	8428	2640	137048	0.00000	0	351	153117
1753	3842	2296	139537	0.000000	0	351	155707
1754	6357	2237	138363	478.500000	0	351	155280
1755	2905	1671	74974	0.000000	0	351	86951
1756	7427	2561	133509	0.000000	0	351	148445
1757 1758	7421 5561	2436 2615	131246 137594	678.500000 545.500000	0	352 352	149303
1758	2305	1503	137594	478.666667	0	354	149248 144237
1760	2303	1513	131142	395.000000	0	354	144237
1761	5744	2463	127286	407.400000	0	355	142567
1762	4846	1914	131724	386.000000	0	357	146274

1763	2656	1653	129964	0.000000	0	359	142071
1764	6516	1845	126700	392.666667	0	359	139067
1765	5035	1906	128650	0.000000	1	359	141048
1766	5465	1986	123625	284.000000	1	359	136816
1767	6980	1952	126834	484.000000	1	358	139761
1768	5779	2239	128868	448.000000	1	357	141862
1769	3514	2245	125037	371.000000	1	357	141271
1770	2631	1718	121657	349.000000	1	357	140935
1771	2350	1532	210626	0.000000	1	357	200335
1772	2225	1428	207869	490.000000	0	358	197464
1773	2344	1313	215188	356.000000	0	357	212084
1774	2101	1351	216360	363.200000	2	358	211717
1775	2085	1382	214338	0.000000	3	356	204617
1776	2155	1388	213310	526.000000	3 5	356 356	213465
1777 1778	2086 1854	1343 1268	218547 223983	341.600000 325.000000	10	354	202373 206637
1779	2038	1374	225413	0.000000	10	355	205982
1780	2058	1302	227835	679.000000	10	355	236828
1781	1805	1243	247239	405.500000	8	355	244274
1782	2204	1480	249043	372.500000	8	356	239129
1783	2081	1399	252074	0.00000	7	357	256071
1784	1926	1299	202575	0.00000	5	356	216693
1785	1891	1223	200993	0.00000	1	357	215754
1786	1732	1159	204089	409.500000	1	357	218364
1787	1740	1109	203267	0.00000	1	358	213418
1788	1731	1220	202685	374.000000	0	357	213428
1789	3139	2297	214882	0.000000	0	356	223061
1790	3296	2339	213361	0.000000	0	356	221820
1791	2980	2095	212867	338.000000	0	356	221742
1792	2591	1821	208083	0.000000	0	356	217384
1793 1794	2433 2342	1668 1547	205480 204942	0.000000	0	356 356	215695 215519
1795	2342	1534	206213	723.000000	0	356	216698
1796	2170	1445	206925	0.000000	0	355	217314
1797	1986	1252	202998	456.000000	0	355	210101
1798	1874	1226	201336	307.000000	0	355	208523
1799	1890	1279	202520	0.00000	0	354	213401
1800	1733	1175	206397	0.00000	0	353	217183
1801	1978	1327	206312	0.00000	0	354	218000
1802	4834	3556	205545	586.000000	0	354	213308
1803	4838	3341	200304	620.000000	0	354	208799
1804	4217	2754	196062	567.000000	0	354	205583
1805	3873	2463	193449	656.000000	0	355	206939
1806	3889	2507	198829	470.000000	0	355	208047
1807	3557	2265	199593	0.000000	0	355	208852
1808 1809	3214	2150	196498	0.000000 568.000000	0	355	206458
1810	3083 2708	2106 1784	192456 196850	583.000000	0	355 355	203043 206785
1811	2560	1627	196593	455.000000	0	355	206763
1812	2421	1579	106171	531.250000	0	359	119038
1813	2304	1500	196080	353.600000	0	359	205839
1814	2184	1449	198032	571.500000	1	359	211118
1815	2097	1298	191821	0.00000	1	359	205129
1816	2084	1361	191425	560.500000	1	359	201896
1817	1930	1326	191678	415.750000	1	359	205514
1818	1955	1311	191748	424.000000	8	359	202477
1819	1874	1284	193442	462.500000	8	359	203946
1820	1737	1216	195785	0.000000	8	359	205524
1821	1672	1176	198361	428.000000	7	360	211446
1822	1613	1187	197539	522.000000	7	360	214899
1823	2742	1968	194216	473.500000	7	361	214339
1824 1825	3032 2507	2038 1727	193181 193933	0.000000 524.000000	7 0	361 361	213470 209600
1825	2507 2588	1655	193933	0.000000	0	361	209600
1827	2407	1565	186517	0.000000	0	363	206082
1828	2394	1496	179335	0.000000	0	363	200002
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1829	2231	1400	184140	599.500000	0	363	204068
1830	2010	1208	183054	389.000000	0	363	203282
1831	1852	1176	198804	0.000000	3	364	218310
1832	1714	1132	194315	531.500000	3	365	214971
1833	1708	1105	198659	512.666667	5	365	218717
1834	1672	1124	201418	386.166667	5	365	220296
1835	1676	1090	205633	0.000000	5	366	224171
1836	1604	1075	208727	578.666667	5	366	226775
1837	1980	1266	208636	403.000000	5	367	226672
1838	2091	1225	196470	0.00000	2	367	216215
1839	1858	1125	203680	0.000000	2	366	222188
1840	1875	1161	197581	0.000000	0	367	217078
1841	1656	1066	196171	0.000000	0	367	215880
1842	1820	1063	195006	0.000000	0	368	213605
1843 1844	1682 1868	1143 1327	197290 197707	0.000000	0	367 367	215599 216407
1845	1841	1204	194372	0.000000	0	367	214011
1846	1838	1195	193151	0.000000	0	366	213490
1847	1617	1100	207535	505.000000	0	366	226366
1848	1592	1064	208233	416.500000	0	366	226834
1849	1700	1213	199393	0.000000	1	367	219295
1850	1613	1168	202501	0.000000	1	368	222335
1851	3999	2864	198891	0.000000	1	367	219410
1852	4176	2993	196651	0.000000	1	367	217766
1853	3826	2516	193603	0.000000	1	367	215172
1854	3479	2230	191422	0.000000	6	367	213120
1855	3268	2175	178585	0.000000	6	367	200714
1856	2961	2032	176328	0.00000	5	367	198909
1857	2881	1918	173750	0.000000	5	367	196521
1858	2105	1373	182049	315.750000	5	367	203594
1859	1684	1128	180046	0.000000	5	367	201658
1860 1861	1689 1524	1098 1063	178864 179979	487.333333 387.500000	5 0	367 366	200640 201731
1862	1548	1057	179379	0.000000	0	366	201731
1863	1519	992	180194	0.000000	0	367	201543
1864	1547	1038	188933	0.000000	0	367	211050
1865	1537	1074	186785	0.000000	0	367	209433
1866	1441	1041	184783	418.000000	0	367	208131
1867	1530	1068	182659	0.000000	1	367	207083
1868	1481	1019	185255	0.000000	1	367	209219
1869	1465	1028	188019	0.000000	1	368	211647
1870	1567	1131	189455	0.000000	1	368	212742
1871	1467	1065	188008	0.000000	1	367	211463
1872	1660	1240	185769	0.000000	1	367	209366
1873	1776	1223	182183	519.000000	0	367	206069
1874	1499	1072	184224	0.000000	0	367	207421
1875	1633	1181	188417	379.000000	0	367	210772
1876	1465	1088	167429	767.000000	0	367	191301
1877 1878	1529 1305	1077 946	167371 171055	0.000000	0	366 366	191400 194453
1879	1444	1083	170906	0.000000	0	366	194640
1880	1478	1097	170680	0.000000	0	366	194550
1881	1780	1225	183220	585.000000	0	366	206789
1882	1627	1187	185749	0.00000	0	366	209485
1883	1654	1213	195792	333.666667	0	366	218675
1884	1549	1176	193640	0.000000	0	366	217194
1885	1647	1185	190217	0.000000	0	365	214396
1886	1681	1262	188106	0.000000	0	365	212330
1887	1707	1244	192868	0.000000	0	365	216490
1888	1720	1192	191441	0.000000	0	366	214965
1889	1575	1127	188660	0.000000	0	366	212279
1890	1661	1124	186542	0.000000	0	366	211061
1891	1643	1089	192326	0.000000	0	366	215632
1892	1590	1192	176393 178235	0.000000 564.000000	0	366 366	200355 201898
1893 1894	2008 2166	1466 1421	178235	0.000000	0	366	201898
107 4	2100	1741	100123	0.00000	U	200	20000

1896	1895	2246	1550	182655	0.000000	1	365	205795
1897								
1898								
1890								
1901		1880		195542	0.000000	2		217194
1902	1900	1802	1325	184383	628.000000	2	366	208283
1903	1901	1828	1321	185287	0.000000	0	368	209004
1904		1926			0.000000			209553
1905								
1906								
1907								
1908								
1909								
1910								
1911								
1912								
1913								
1914								
1916							370	
1917 2433 1666 93105 0.000000 0 370 109935 1918 2406 1684 95780 524,000000 0 370 112442 1919 2148 1543 84317 0.000000 0 370 1022075 1920 2122 1540 85672 0.000000 0 370 102921 1921 2352 1706 178674 0.000000 0 369 198229 1923 2396 1676 174595 0.000000 0 368 197171 1924 2637 1608 177983 0.000000 0 368 197171 1925 2315 1501 172809 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 195333 1927 2112 1484 156524 0.000000 0 367 189898 1929 2954	1915	2388	1672	70581	0.000000	0	370	88448
1918	1916	2474	1726	68621	496.000000	0	370	83620
1919	1917	2433	1666	93105	0.000000	0	370	109935
1920 2122 1540 85672 0.000000 0 370 102921 1921 2352 1706 178674 0.000000 0 370 200873 1922 2472 1669 175569 0.000000 0 368 197171 1924 2637 1608 177983 0.000000 0 368 197171 1924 2637 1608 177983 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 19333 1926 2301 1550 170240 0.000000 0 367 18804 1928 3057 2167 158883 0.000000 0 367 18840 1928 3057 2167 158883 0.000000 0 367 182756 1930 2901	1918	2406	1684	95780	524.000000	0	370	112442
1921 2352 1706 178674 0.000000 0 370 200873 1922 2472 1669 175569 0.000000 0 369 198229 1923 2396 1676 174595 0.000000 0 367 19986 1925 2315 1501 172809 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 192329 1927 2112 1484 156524 0.000000 0 367 180884 1928 3057 2167 158883 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 18245 1931 2842 1886 155106 0.000000 0 367 181421 1931 2845								
1922 2472 1669 175569 0.000000 0 369 198229 1923 2396 1676 174595 0.000000 0 368 197171 1924 2637 1608 177983 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 192329 1927 2112 1484 156524 0.000000 0 368 178840 1928 3057 2167 158883 0.000000 0 367 180989 1929 2954 2062 160917 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 181421 1933 2895 1858 154096 0.000000 0 368 177339 1934 2602								
1923 2396 1676 174595 0.000000 0 368 197171 1924 2637 1608 177983 0.000000 0 367 199986 1925 2315 1501 172809 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 192329 1927 2112 1484 156524 0.000000 0 367 180989 1928 3057 2167 158883 0.000000 0 367 180989 1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 181421 1931 2842 1886 155106 0.000000 0 367 181421 1933 2895 1858 154096 0.000000 0 368 177380 1934 2602								
1924 2637 1608 177983 0.000000 0 367 19986 1925 2315 1501 172809 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 195333 1927 2112 1484 156524 0.000000 0 367 180989 1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 182756 1932 2806 1912 159061 0.000000 0 367 181421 1931 2845 154098 0.000000 0 368 177339 1934 2602 1735								
1925 2315 1501 172809 0.000000 0 368 195333 1926 2301 1550 170240 0.000000 0 368 192329 1927 2112 1484 156524 0.000000 0 368 178840 1928 3057 2167 158883 0.000000 0 367 189989 1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 18421 1932 2806 1912 159061 0.000000 0 368 177339 1933 2895 1858 154096 0.000000 0 367 193002 1936 2385								
1926 2301 1550 170240 0.000000 0 368 192329 1927 2112 1484 156524 0.000000 0 368 178840 1928 3057 2167 158883 0.000000 0 367 180989 1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 181421 1932 2806 1912 159061 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 368 177339 1935 2470 1784 169973 0.000000 0 366 10662 1937 2275 1580 91363 0.000000 0 366 108366 1938 2226								
1927 2112 1484 156524 0.000000 0 368 178840 1928 3057 2167 158883 0.000000 0 367 180989 1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 178234 1932 2806 1912 159061 0.000000 0 367 181421 1933 2895 1858 154096 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 366 10612 1937 2275 1580 91363 0.000000 0 366 10632 1936 2385 1591 9094 0.000000 0 367 193002 1936 2385								
1928 3057 2167 158883 0.000000 0 367 180989 1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 178234 1932 2806 1912 159061 0.000000 0 367 181421 1933 2895 1858 154098 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 368 177380 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 10355 1940 2069								
1929 2954 2062 160917 0.000000 0 367 182756 1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 178234 1932 2806 1912 159061 0.000000 0 367 181421 1933 2895 1858 154096 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 367 193002 1935 2470 1784 169973 0.000000 0 366 106612 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 106812 1938 2225 1520 87277 0.000000 0 367 103855 1940 2069								
1930 2901 1947 161596 0.000000 0 367 183014 1931 2842 1886 155106 0.000000 0 367 178234 1932 2806 1912 159061 0.000000 0 367 181421 1933 2895 1858 154098 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 367 193002 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 93772 1941 1981 1388 7747 0.000000 0 367 95009 1942 2465								
1931 2842 1886 155106 0.000000 0 367 178234 1932 2806 1912 159061 0.000000 0 367 181421 1933 2895 1858 154096 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 368 177339 1935 2470 1784 169973 0.000000 0 366 106612 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465								
1933 2895 1858 154096 0.000000 0 368 177380 1934 2602 1735 154098 0.000000 0 368 177339 1935 2470 1784 169973 0.000000 0 367 193002 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 103855 1940 2069 1440 76326 226.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 368 175009 1943	1931	2842	1886		0.000000	0	367	178234
1934 2602 1735 154098 0.000000 0 368 177339 1935 2470 1784 169973 0.000000 0 367 193002 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 103855 1940 2069 1440 76326 226.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 <	1932	2806	1912	159061	0.000000	0	367	181421
1935 2470 1784 169973 0.000000 0 367 193002 1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 103855 1940 2069 1440 76326 226.000000 0 367 95009 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 368 180884 1943 2331 1681 160527 0.000000 0 368 175905 1945 2532 1783 142524 578.000000 0 366 173068 1947 2166	1933	2895	1858	154096	0.000000	0	368	177380
1936 2385 1591 90094 0.000000 0 366 106612 1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 103855 1940 2069 1440 76326 226.000000 0 367 95009 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 367 97949 1943 2331 1681 160527 0.000000 0 368 180884 1944 2340 1651 154773 524.000000 0 366 164592 1945 2532 1783 142524 578.000000 0 366 173068 1947 2166	1934	2602	1735			0		
1937 2275 1580 91363 0.000000 0 366 108366 1938 2225 1520 87277 0.000000 0 367 104554 1939 2216 1502 86850 243.500000 0 367 103855 1940 2069 1440 76326 226.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 367 97949 1943 2331 1681 160527 0.000000 0 368 180884 1944 2340 1651 154773 524.000000 0 366 164592 1945 2532 1783 142524 578.000000 0 366 173068 1947 2166 1480 152973 426.000000 0 366 177303 1948 1923								
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1939 2216 1502 86850 243.500000 0 367 103855 1940 2069 1440 76326 226.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 367 97949 1943 2331 1681 160527 0.000000 0 368 180884 1944 2340 1651 154773 524.000000 0 366 164592 1945 2532 1783 142524 578.000000 0 366 164592 1946 2281 1648 152527 327.000000 0 366 173068 1947 2166 1480 152973 426.000000 0 366 173101 1948 1923 1428 157836 0.000000 0 366 177454 1950 2115 1404 153240 0.000000 0 366 173565 <								
1940 2069 1440 76326 226.000000 0 367 93772 1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 367 97949 1943 2331 1681 160527 0.000000 0 368 180884 1944 2340 1651 154773 524.000000 0 368 175905 1945 2532 1783 142524 578.000000 0 366 164592 1946 2281 1648 152527 327.000000 0 366 173068 1947 2166 1480 152973 426.000000 0 366 173101 1948 1923 1428 157836 0.000000 0 366 177303 1949 1940 1413 153075 0.000000 0 366 177454 1950 2115 1404 153240 0.000000 0 367 180826 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								
1941 1981 1388 77747 0.000000 0 367 95009 1942 2465 1812 80237 0.000000 0 367 97949 1943 2331 1681 160527 0.000000 0 368 180884 1944 2340 1651 154773 524.000000 0 366 164592 1945 2532 1783 142524 578.000000 0 366 164592 1946 2281 1648 152527 327.000000 0 366 173068 1947 2166 1480 152973 426.000000 0 366 173101 1948 1923 1428 157836 0.000000 0 366 177303 1949 1940 1413 153075 0.000000 0 366 177454 1950 2115 1404 153240 0.000000 0 366 173565 1951 1853 1456 159900 0.000000 0 367 180826 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								
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1950 2115 1404 153240 0.0000000 0 366 173565 1951 1853 1456 159900 0.000000 0 366 182754 1952 2024 1509 157000 338.000000 0 367 180826 1953 2213 1414 157231 0.000000 0 367 179706 1954 1892 1402 149995 0.000000 0 367 174156 1955 1669 1269 165640 0.000000 0 367 190712 1956 1851 1371 167088 0.000000 0 367 192152 1957 1934 1436 160550 0.000000 0 367 187333 1958 1806 1360 158182 0.000000 0 366 190443 1959 1985 1430 161890 286.500000 0 366 193309					0.000000	0		
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1952 2024 1509 157000 338.000000 0 367 180826 1953 2213 1414 157231 0.000000 0 367 179706 1954 1892 1402 149995 0.000000 0 367 174156 1955 1669 1269 165640 0.000000 0 367 190712 1956 1851 1371 167088 0.000000 0 367 192152 1957 1934 1436 160550 0.000000 0 367 187333 1958 1806 1360 158182 0.000000 0 366 190443 1959 1985 1430 161890 286.500000 0 366 193309								
1953 2213 1414 157231 0.000000 0 367 179706 1954 1892 1402 149995 0.000000 0 367 174156 1955 1669 1269 165640 0.000000 0 367 190712 1956 1851 1371 167088 0.000000 0 367 192152 1957 1934 1436 160550 0.000000 0 367 187333 1958 1806 1360 158182 0.000000 0 366 190443 1959 1985 1430 161890 286.500000 0 366 193309								
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1958 1806 1360 158182 0.000000 0 366 190443 1959 1985 1430 161890 286.500000 0 366 193309								
1959 1985 1430 161890 286.500000 0 366 193309								
1960 2038 1501 164682 0.000000 0 366 196097	1960	2038	1501	164682	0.000000	0		

```
1977
                      1498 164845 301.666667
                                                    367
         1961
                                                         195957
         1962
                 2043 1560 166158 231.500000
                                                 0 367 197279
         1963
                2497 1752 147652 0.000000
                                               0 367 177915
         1964
                2442 1705 148909
                                    0.000000
                                               0 367 179348
                                               0 367 177138
                                    0.000000
         1965
                2499 1745 146850
              2360 1579 150009 0.000000
                                               0 367 178997
         1966
              2219 1566 144635
                                               0 367 174217
         1967
                                    0.000000
              2289 1658 145801
                                    0.000000
                                                0 367 174965
         1968
              2290 1567 144494 0.000000
                                               0 367 173293
         1969
                                               0 367 175380
              3084 2259 146153 0.000000
         1970
         1971
               3282 2221 145220
                                    0.000000
                                               0 367 174476

      2925
      2035
      144031
      0.000000
      3 367 173381

      2932
      2052
      147408
      445.6666667
      0 368 175850

         1972
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         1974
              2886 2023 148046
                                    0.000000 3 368 176578
              2797 1925 147921
                                    0.000000 3 368 176678
         1975
                                               3 367 192698
                                    0.000000
         1976
              2541 1668 163246
               3148 2001 164039
                                                 3 367 193488
         1977
                                    0.000000
              2669 1789 164348 376.250000 13 368 193759
         1978
              2481 1783 161081
         1979
                                    0.000000 11 370 190975
         1980
              2712 1814 160728 465.000000
                                                 12 370 190149
              2817 1859 145553 402.000000 16 371 174517
         1981
         1982
              2761 1755 140862
                                    0.000000 16 372 170358
              2846 1926 157238 612.000000 16 372 187196
         1983
         1984
               4286 2937 137573 515.000000 15 373 167402
         1985
              4613 3254 135038
                                   0.000000
                                               5 373 164676
              3883 2792 137122
3900 2840 138403
                                                5 373 166167
         1986
                                    0.000000
                                               0 374 166467
         1987
                                    0.000000
         1988
              4543 3380 141684 412.000000
                                               0 374 168679
         1989
              4862 3657 140256 367.666667
                                               0 375 167178
                                               0 375 163913
0 375 164482
              4602 3414 136841
         1990
                                    0.000000
         1991
               4732 3487 137575
                                    0.000000
                                               0 376 162632
         1992
              4828 3448 135642
                                    0.000000
         1993
              4510 3231 129767 360.000000
                                               0 377 157028
                                    0.000000 0 378 170130
0.000000 0 379 168785
         1994
              4539 3324 141365
         1995
              4644 3429 139969
         1996
              3643 2700 135621
                                    0.000000 0 380 164893

      4458
      3301
      132797
      0.000000
      0
      381
      161959

      5430
      4137
      131006
      291.500000
      2
      381
      160044

              4458 3301 132797
         1997
         1998
         1999
              5917 4513 128797 0.000000 2 381 157601
                                    0.000000 2 381 143391
         2000
              6479 4782 117195
                                               2 381 142352
               5854 4571 116277
         2001
                                    0.000000
                5476 4283 114926 559.000000 2 382 140372
         2002
In [31]:
         Data n = pd.DataFrame()
         Data n.index = Data.index
         Data n['nSt'] = Data['S'].to numpy() / Data['S'].to numpy()[0]
         Data n['nLi'] = Data['L'].to numpy() / Data['L'].to numpy()[0]
         Data n['nInR'] = Data['IGR'].to numpy() / Data['IGR'].to numpy()[0]
         Data n['nTwF'] = Data['TWF'].to numpy() / Data['TWF'].to numpy()[0]
         Data n['nChC'] = Data['CPP'].to numpy() / Data['CPP'].to numpy()[0]
         Data n['nChE'] = Data['EGR'].to numpy() / Data['EGR'].to numpy()[0]
         Data n
```

Out[31]:		nSt	nLi	nInR	nTwF	nChC	nChE
	0	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
	1	8.285714	1.000000	0.904698	1.000000	1.046179	1.066994
	2	8.428571	1.142857	0.884116	1.004425	1.061623	1.074565
	3	8.142857	0.571429	0.961074	1.004425	1.070980	1.089096
	4	2.714286	0.714286	0.970022	1.004425	1.068574	1.084590
	•••						

	nSt	nLi	nInR	nTwF	nChC	nChE
1998	775.714286	591.000000	1.565101	1.685841	0.343542	0.345249
1999	845.285714	644.714286	0.000000	1.685841	0.338298	0.339427
2000	925.571429	683.142857	0.000000	1.685841	0.307796	0.308852
2001	836.285714	653.000000	0.000000	1.685841	0.305566	0.306432
2002	782.285714	611.857143	3.001342	1.690265	0.301315	0.302872

2003 rows × 6 columns

In [32]:

Data

Out[32]:

82]:		Date	Platform	DateWk	DayWk	Month	Year	S	L	TWF	TWR	EGR	СРР	IG
	0	2020- 03- 04	Apple Music	Wednesday	4	3	2020	7	7	226	0	379454	465864	186.25000
	1	2020- 03- 05	Apple Music	Thursday	5	3	2020	58	7	226	0	404875	487377	168.50000
	2	2020- 03- 06	Apple Music	Friday	6	3	2020	59	8	227	0	407748	494572	164.66666
	3	2020- 03-07	Apple Music	Saturday	7	3	2020	57	4	227	0	413262	498931	179.00000
	4	2020- 03- 08	Apple Music	Sunday	1	3	2020	19	5	227	0	411552	497810	180.66666
	•••													
	1998	2021- 12-27	Spotify	Monday	2	12	2021	5430	4137	381	2	131006	160044	291.50000
	1999	2021- 12-28	Spotify	Tuesday	3	12	2021	5917	4513	381	2	128797	157601	0.00000
	2000	2021- 12-29	Spotify	Wednesday	4	12	2021	6479	4782	381	2	117195	143391	0.00000
	2001	2021- 12-30	Spotify	Thursday	5	12	2021	5854	4571	381	2	116277	142352	0.00000
	2002	2021- 12-31	Spotify	Friday	6	12	2021	5476	4283	382	2	114926	140372	559.00000

2003 rows × 14 columns

```
In [33]: DataIn = Data[['Platform', 'Date']]
    Data.index = pd.MultiIndex.from_frame(DataIn)
    type(Data.index)
```

Out[33]: pandas.core.indexes.multi.MultiIndex

Checking the Correlation Coefficients on the above variables;

In [34]:

```
Out[34]:
                                     EGR
                                              CPP
                                                        IGR
                                                                TWR
                                                                          TWF
               1.000000
                        0.281764 -0.143763
                                          -0.147351
                                                    0.075017 -0.022556
                                                                       0.134985
               0.281764
                        1.000000 -0.399742 -0.413992
                                                    0.054268
                                                             0.022768
                                                                      0.493749
          EGR -0.143763 -0.399742
                                 1.000000
                                          0.993352 -0.082037
                                                             -0.152661 -0.676003
          CPP
               -0.147351 -0.413992
                                 0.993352
                                          1.000000 -0.105323
                                                            -0.164579 -0.703309
          IGR
               1.000000
                                                             0.218519 -0.011468
         TWR -0.022556 0.022768 -0.152661 -0.164579
                                                   0.218519
                                                             1.000000
                                                                      -0.091411
         TWF 0.134985 0.493749 -0.676003 -0.703309 -0.011468 -0.091411 1.000000
            # Checking the length of the 'Panel' Dataset
In [35]:
          Data DSP = pd.DataFrame(Data[['S','L','EGR','CPP','IGR','TWR','TWF']])
          Data DSPk = Data DSP.shape[0]
          n sample = int(Data DSPk)
          print(n sample)
          type(n sample)
         2003
         int
Out[35]:
            # Isolating the quantitative variables we are interested, isolated by DSP
In [36]:
          AM = Data.query("Platform == 'Apple Music'")
          SC = Data.query("Platform == 'SoundCloud'")
          SP = Data.query("Platform == 'Spotify'")
          AM e = AM[['S','L','EGR','CPP','IGR','TWR','TWF']]
          SC e = SC[['S','L','EGR','CPP','IGR','TWR','TWF']]
          SP e = SP[['S','L','EGR','CPP','IGR','TWR','TWF']]
          AM e = AM[['S','L','EGR','CPP','IGR','TWR','TWF']]
          SC e = SC[['S','L','EGR','CPP','IGR','TWR','TWF']]
          SP e = SP[['S','L','EGR','CPP','IGR','TWR','TWF']]
            # Checking the VIF's of 'Data_DSP'
In [37]:
          print(f"Corr. Coeff.'s \n{Data DSP.corr()}\n")
          corrData1 = Data DSP.corr()
          ax = sns.heatmap(
              corrData1,
              vmin=-1, vmax=1, center=0,
              cmap=sns.diverging palette(20, 220, n=200),
              square=True)
          ax.set xticklabels(
              ax.get xticklabels(),
              rotation=45,
              horizontalalignment='right')
         Corr. Coeff.'s
                                                  CPP
                                        EGR
                                                            IGR
                                                                       TWR
```

 $1.000000 \quad 0.281764 \quad -0.143763 \quad -0.147351 \quad 0.075017 \quad -0.022556 \quad 0.134985$

Data[['S','L','EGR','CPP','IGR','TWR','TWF']].corr()

```
0.281764 \quad 1.000000 \quad -0.399742 \quad -0.413992 \quad 0.054268 \quad 0.022768 \quad 0.493749
          EGR -0.143763 -0.399742 1.000000 0.993352 -0.082037 -0.152661 -0.676003
          CPP -0.147351 -0.413992 0.993352 1.000000 -0.105323 -0.164579 -0.703309
          IGR 0.075017 0.054268 -0.082037 -0.105323 1.000000 0.218519 -0.011468
          TWR -0.022556 0.022768 -0.152661 -0.164579 0.218519 1.000000 -0.091411
          TWF 0.134985 0.493749 -0.676003 -0.703309 -0.011468 -0.091411 1.000000
Out[37]: [Text(0.5, 0, 'S'),
           Text(1.5, 0, 'L'),
           Text(2.5, 0, 'EGR'),
           Text(3.5, 0, 'CPP'),
           Text(4.5, 0, 'IGR'),
           Text(5.5, 0, 'TWR'),
           Text(6.5, 0, 'TWF')]
                                               1.00
                                                0.75
                                               - 0.50
          EGR
                                               - 0.25
          占
                                               - 0.00
                                               - -0.25
          GR
          TWR
                                               - -0.50
                                                -0.75
```

-1.00

Plotting function: Time-Series plot Histogram Autocorrelation Function(ACF) Partial Autocorrelation Function(pACF)

CR THR

~ "Cb Gb

In [38]:

```
# Source:
    # https://github.com/SimiY...
    # .../pydata-sf-2016-arima-tutorial/blob/master/Section 3 ARIMA Modeling tutorial.ipyi
#Choose the number of lags to display the sample ACF and PACF;
n lag=25
#graph title='Series 1'
# Writing a function to plot this specific sub-section of data;
#Make sure the tsplot() function is defined; #**Function: See dji citi sent file;
def tsplot(y1, y2, lags=None, title='', figsize=(14,8)):
    '''Examine the patterns of ACF and PACF, along with the time series plots and histogra-
    Original source: https://tomaugspurger.github.io/modern-7-timeseries.html
    1.1.1
    # Plotting layout
    fig = plt.figure(figsize=figsize)
    layout = (2,2)
    ts ax = plt.subplot2grid(layout, (0,0))
   hist ax = plt.subplot2grid(layout, (0,1))
    acf ax = plt.subplot2grid(layout, (1,0))
    pacf ax = plt.subplot2grid(layout, (1,1))
    #Plotting
    y1.plot(ax=ts ax)
    ts ax.set title(title)
    y2.plot(ax=hist ax, kind='hist', bins=25)
```

```
# Function for rotating tick labels on x-axis only
for tick in ts_ax.get_xticklabels():
    tick.set_rotation(45)

ts_ax.legend(loc='upper left')
hist_ax.set_title('Histogram')
smt.graphics.plot_acf(y2, lags=lags, ax=acf_ax)
smt.graphics.plot_pacf(y2, lags=lags, ax=pacf_ax)
[ax.set_xlim(0) for ax in [acf_ax, pacf_ax]]
sns.despine()
plt.tight_layout()

return ts_ax, acf_ax, pacf_ax
```

Time-Series, Histogram, ACF and pACF isolated by DSP

```
In [39]:
          #Run command;
          tsplot(AM['S'],
                 AM['S'],
                 title='Apple Music Streams ' ,
                 lags=n lag)
          #Run command;
          tsplot(AM['S'],
                 AM['S'],
                 title='Apple Music Listeners ' ,
                 lags=n lag)
          #Run command;
          tsplot(SC['S'],
                 SC['S'],
                 title='SoundCloud Streams',
                 lags=n lag)
          #Run command;
          tsplot(SC['S'],
                 SC['S'],
                 title='SoundCloud Listeners',
                 lags=n lag)
          #Run command;
          tsplot(SP['S'],
                 SP['S'],
                 title='Spotify Streams ' ,
                 lags=n lag)
          #Run command;
          tsplot(SP['S'],
                 SP['S'],
                 title='Spotify Listeners',
                 lags=n lag)
```

/opt/anaconda3/lib/python3.8/site-packages/statsmodels/graphics/tsaplots.py:348: FutureWar ning: The default method 'yw' can produce PACF values outside of the [-1,1] interval. Afte r 0.13, the default will change tounadjusted Yule-Walker ('ywm'). You can use this method now by setting method='ywm'.

warnings.warn(

/opt/anaconda3/lib/python3.8/site-packages/statsmodels/graphics/tsaplots.py:348: FutureWar ning: The default method 'yw' can produce PACF values outside of the [-1,1] interval. Afte r 0.13, the default will change tounadjusted Yule-Walker ('ywm'). You can use this method now by setting method='ywm'.

warnings.warn(

/opt/anaconda3/lib/python3.8/site-packages/statsmodels/graphics/tsaplots.py:348: FutureWar ning: The default method 'yw' can produce PACF values outside of the [-1,1] interval. Afte

r 0.13, the default will change tounadjusted Yule-Walker ('ywm'). You can use this method now by setting method='ywm'.

warnings.warn(

/opt/anaconda3/lib/python3.8/site-packages/statsmodels/graphics/tsaplots.py:348: FutureWar ning: The default method 'yw' can produce PACF values outside of the [-1,1] interval. Afte r 0.13, the default will change tounadjusted Yule-Walker ('ywm'). You can use this method now by setting method='ywm'.

warnings.warn(

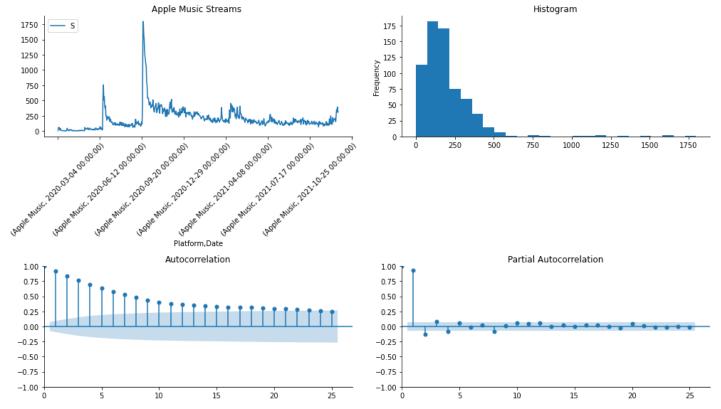
/opt/anaconda3/lib/python3.8/site-packages/statsmodels/graphics/tsaplots.py:348: FutureWar ning: The default method 'yw' can produce PACF values outside of the [-1,1] interval. After 0.13, the default will change tounadjusted Yule-Walker ('ywm'). You can use this method now by setting method='ywm'.

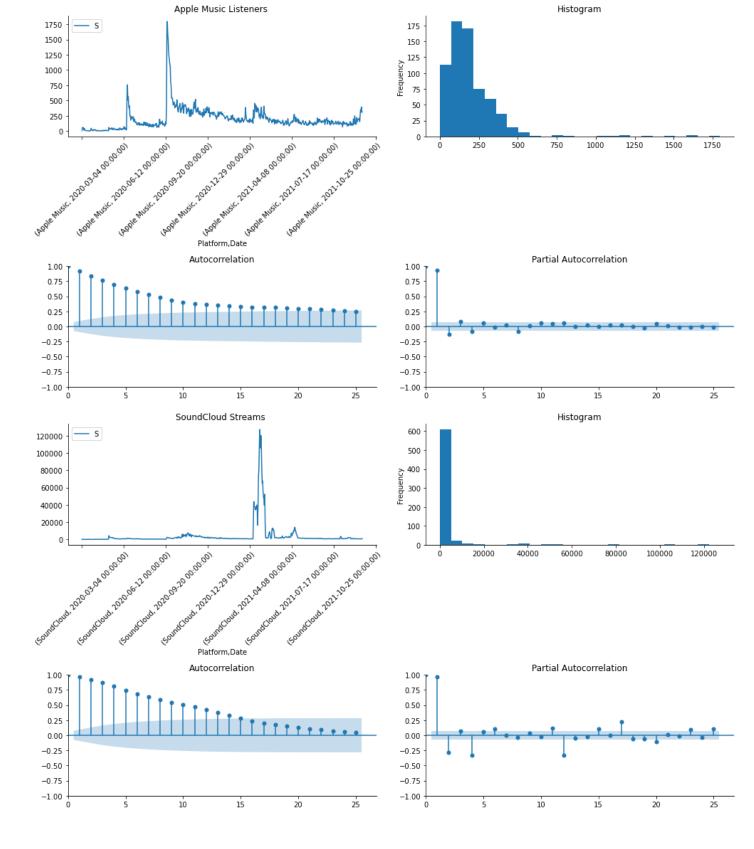
warnings.warn(

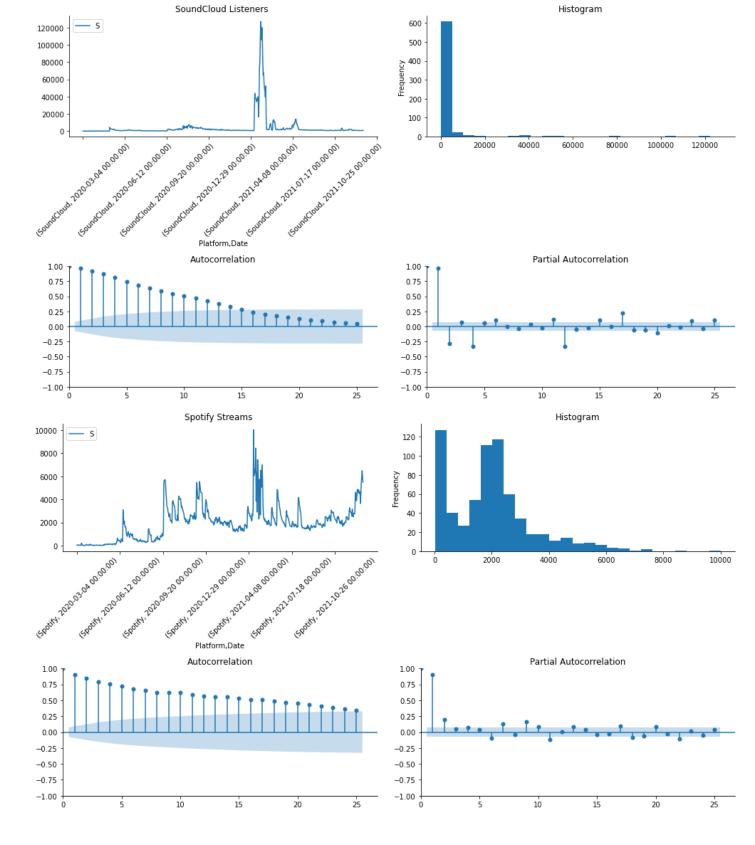
/opt/anaconda3/lib/python3.8/site-packages/statsmodels/graphics/tsaplots.py:348: FutureWar ning: The default method 'yw' can produce PACF values outside of the [-1,1] interval. Afte r 0.13, the default will change tounadjusted Yule-Walker ('ywm'). You can use this method now by setting method='ywm'.

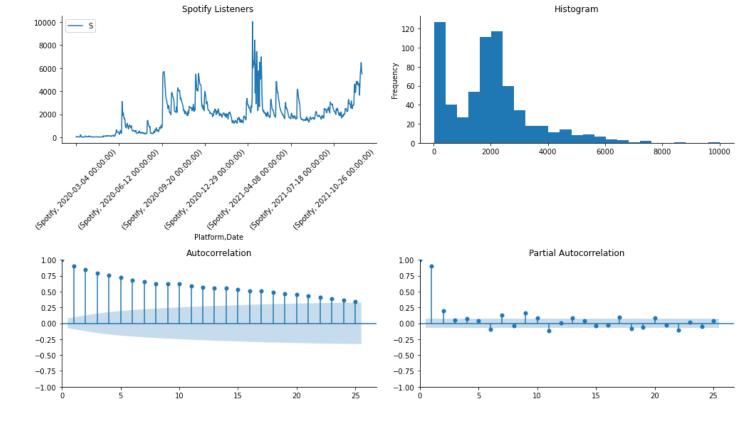
warnings.warn(

<AxesSubplot:title={'center':'Partial Autocorrelation'}>)



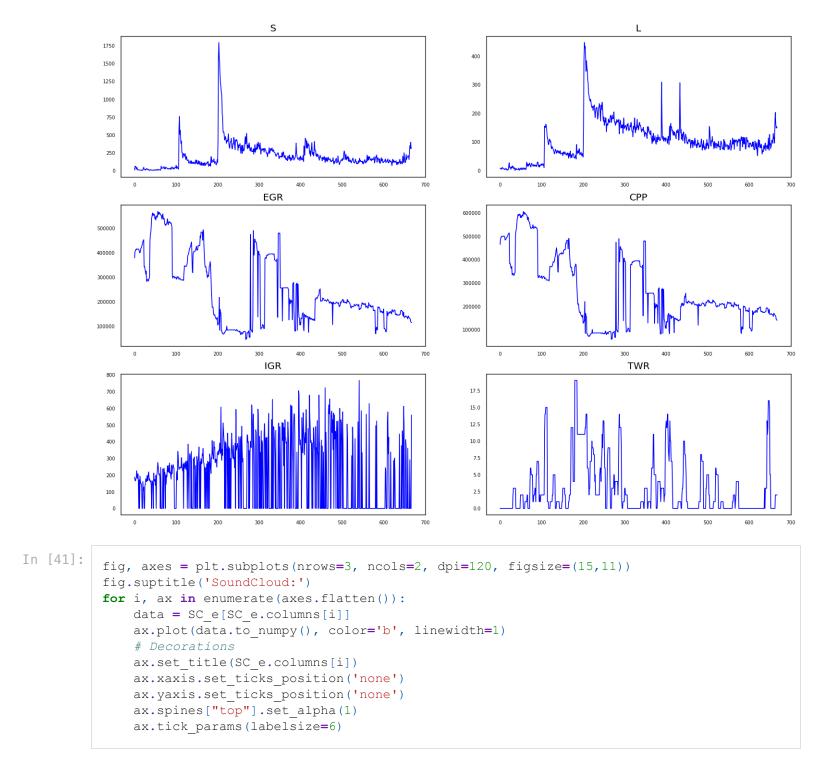


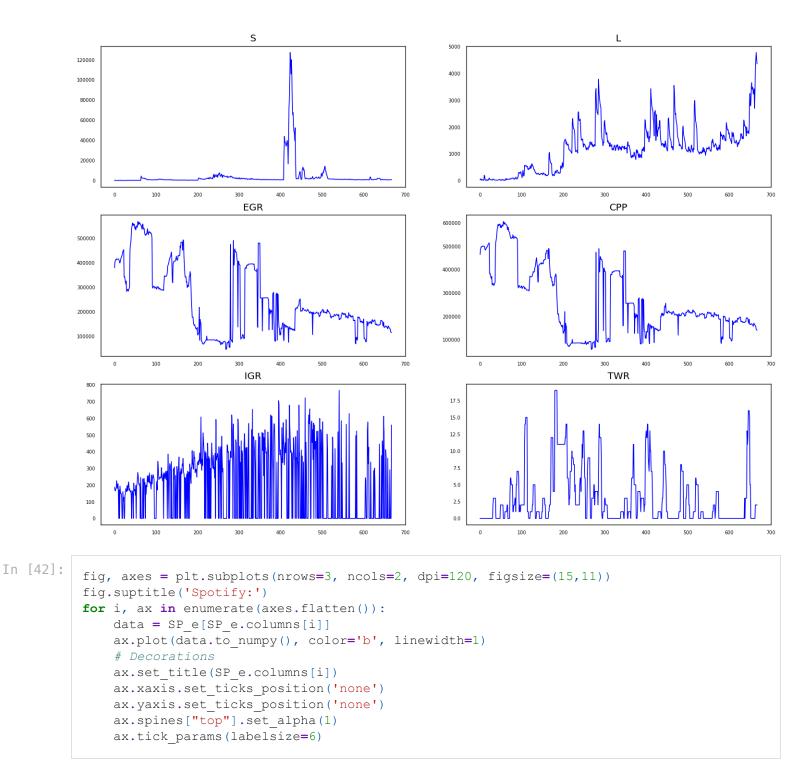




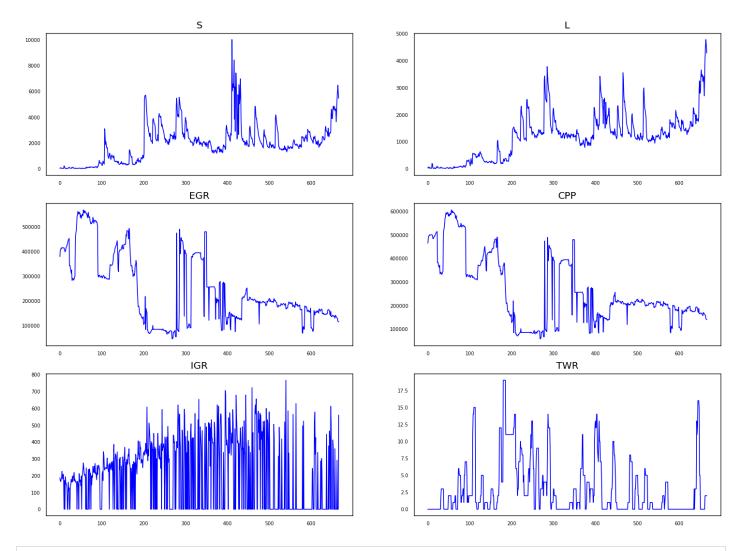
Time-Series plots of each variable we are interested in, isolated by DSP

```
In [40]:
    fig, axes = plt.subplots(nrows=3, ncols=2, dpi=120, figsize=(15,11))
    fig.suptitle('Apple Music:')
    for i, ax in enumerate(axes.flatten()):
        data = AM_e[AM_e.columns[i]]
        ax.plot(data.to_numpy(), color='b', linewidth=1)
        # Decorations
        ax.set_title(AM_e.columns[i])
        ax.xaxis.set_ticks_position('none')
        ax.yaxis.set_ticks_position('none')
        ax.spines["top"].set_alpha(1)
        ax.tick_params(labelsize=6)
```





Spotify:

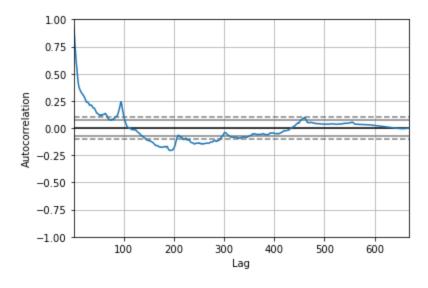


In [43]: from pandas.plotting import autocorrelation_plot

Apple Music

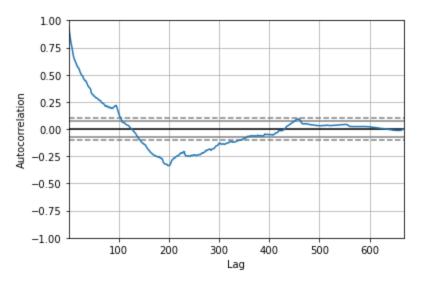
In [44]: autocorrelation_plot(AM_e['S'])

Out[44]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



In [45]: autocorrelation_plot(AM_e['L'])

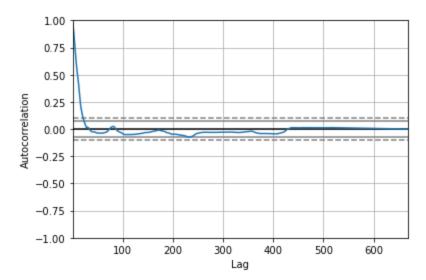
Out[45]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



SoundCloud:

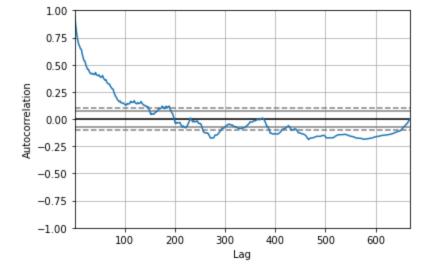
```
In [46]: autocorrelation_plot(SC_e['S'])
```

Out[46]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



```
In [47]: autocorrelation_plot(SC_e['L'])
```

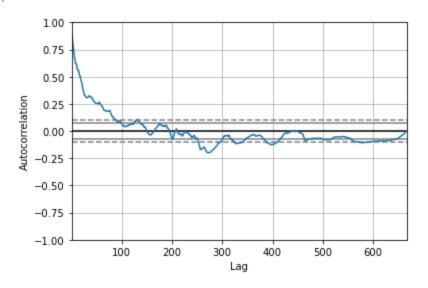
Out[47]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



Spotify:

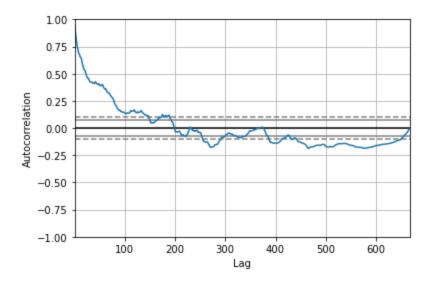
```
In [48]: autocorrelation_plot(SP_e['S'])
```

Out[48]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



```
In [49]: autocorrelation_plot(SP_e['L'])
```

Out[49]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>

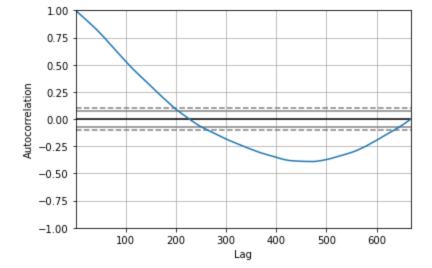


Panel Dataset structure: NOTE Social Media Metrics are the same for each DSP

```
DSP
In [50]:
            autocorrelation plot(AM e['IGR'])
            <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>
Out[50]:
               0.75
               0.50
           Autocorrelation
               0.25
               0.00
              -0.25
              -0.50
              -0.75
              -1.00
                           100
                                   200
                                           300
                                                   400
                                                           500
                                                                   600
                                              Lag
In [51]:
            autocorrelation plot(AM e['TWR'])
            <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>
Out[51]:
               1.00
               0.75
               0.50
           Autocorrelation
               0.25
               0.00
              -0.25
              -0.50
              -0.75
              -1.00
                           100
                                   200
                                           300
                                                   400
                                                           500
                                                                   600
                                              Lag
```

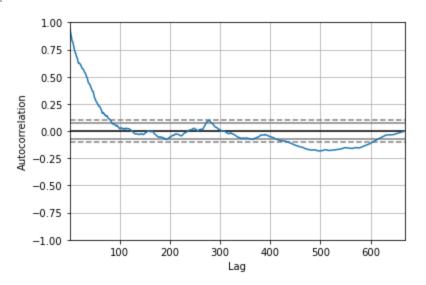
```
In [52]: autocorrelation_plot(AM_e['TWF'])
```

Out[52]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



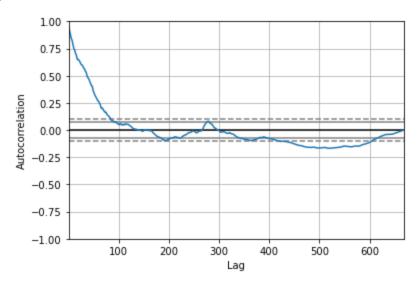
```
In [53]: autocorrelation_plot(AM_e['EGR'])
```

Out[53]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



```
In [54]: autocorrelation_plot(AM_e['CPP'])
```

Out[54]: <AxesSubplot:xlabel='Lag', ylabel='Autocorrelation'>



Yule-Walker Estimates, lag order of 2, for each set of variables we are interested in isolated by DSP

```
In [55]:
          print("Yule-Walker Estimates: Apple Music")
          for i,col in zip(AM e, AM e.columns):
              rho, sigma = yule walker(AM e[i], 2, method='mle')
              print(col)
              print(f'rho: {-rho}')
              print(f'sigma: {sigma}')
         Yule-Walker Estimates: Apple Music
         rho: [-1.04574226 0.12909676]
         sigma: 69.6621848455076
         rho: [-0.87424984 -0.07028027]
         sigma: 22.831740135352174
         rho: [-0.76309646 -0.191057 ]
         sigma: 45830.689954129004
         rho: [-0.76484551 -0.19378794]
         sigma: 45325.426903731764
         IGR
         rho: [-0.22085666 -0.13416891]
         sigma: 193.05862878050834
         TWR
         rho: [-1.01429734 0.12168587]
         sigma: 1.7776190348604675
         rho: [-0.99746586 0.00141916]
         sigma: 4.4351325876760495
In [56]:
          print("Yule-Walker Estimates: SoundCloud")
          for i,col in zip(SC e, SC e.columns):
              rho, sigma = yule walker(SC e[i], 2, method='mle')
              print(col)
              print(f'rho: {-rho}')
              print(f'sigma: {sigma}')
         Yule-Walker Estimates: SoundCloud
         rho: [-1.22564128 0.26704937]
         sigma: 3335.6806844446073
         rho: [-1.0032068
                            0.06221035]
         sigma: 277.7653067915043
         rho: [-0.76309646 -0.191057 ]
         sigma: 45830.689954129004
         CPP
         rho: [-0.76484551 -0.19378794]
         sigma: 45325.426903731764
         rho: [-0.22085666 -0.13416891]
         sigma: 193.05862878050834
         rho: [-1.01429734 0.12168587]
         sigma: 1.7776190348604675
         TWF
         rho: [-0.99746586 0.00141916]
         sigma: 4.4351325876760495
In [57]:
          print("Yule-Walker Estimates: Spotify")
```

print("Yule-Walker Estimates: Spotify")
for i,col in zip(SP_e, SP_e.columns):
 rho, sigma = yule_walker(SP_e[i], 2, method='mle')

```
rho: [-0.72223545 -0.196242 ]
         sigma: 638.4953807007424
         rho: [-1.00661023 0.06534222]
         sigma: 276.75936839691843
         rho: [-0.76308747 -0.19106258]
         sigma: 45864.53546384646
         CPP
         rho: [-0.76482398 -0.19380649]
         sigma: 45358.48850991298
         rho: [-0.22005651 -0.13336461]
         sigma: 193.13465541977112
         rho: [-1.01425106 0.12172991]
         sigma: 1.7789202001689406
         TWF
         rho: [-0.99746069 0.00141601]
         sigma: 4.437930995008709
            # Augmented Dickey-Fuller Test Results for each variable we are interested
            in, isolated by DSP
In [58]:
          print("Augmented Dickey-Fuller Results, Apple Music")
          for i,col in zip(AM e, AM e.columns):
              ad fullerAM = adfuller(AM e[i])
              print(col)
              print(f'ADF Statistic: {ad fullerAM[0]}')
              print(f'p-value: {ad fullerAM[1]}\n')
         Augmented Dickey-Fuller Results, Apple Music
         ADF Statistic: -4.937462452462523
         p-value: 2.9468272780574956e-05
         ADF Statistic: -3.7378466124229353
         p-value: 0.0036112276226828335
         EGR
         ADF Statistic: -2.069552521285494
         p-value: 0.2569325717213009
         CPP
         ADF Statistic: -2.146096882158832
         p-value: 0.2263870939802673
         ADF Statistic: -3.6998367388235267
         p-value: 0.004115451139504546
         TWR
         ADF Statistic: -3.5622550808946536
         p-value: 0.006525009362436266
         TWF
         ADF Statistic: -2.225054644810526
```

print(col)

print(f'rho: {-rho}')
print(f'sigma: {sigma}')

Yule-Walker Estimates: Spotify

p-value: 0.1972780439230385

```
In [59]:
          print("Augmented Dickey-Fuller Results, SoundCloud")
          for i,col in zip(SC e, SC e.columns):
              ad fullerSC = adfuller(SC e[i])
              print(col)
              print(f'ADF Statistic: {ad fullerSC[0]}')
              print(f'p-value: {ad fullerSC[1]}\n')
         Augmented Dickey-Fuller Results, SoundCloud
         ADF Statistic: -4.2523585136523545
         p-value: 0.0005366019929134689
         ADF Statistic: -0.9073730785243389
         p-value: 0.7855346607055639
         EGR
         ADF Statistic: -2.069552521285494
         p-value: 0.2569325717213009
         CPP
         ADF Statistic: -2.146096882158832
         p-value: 0.2263870939802673
         ADF Statistic: -3.6998367388235267
         p-value: 0.004115451139504546
         TWR
         ADF Statistic: -3.5622550808946536
         p-value: 0.006525009362436266
         TWF
         ADF Statistic: -2.225054644810526
         p-value: 0.1972780439230385
In [60]:
          print("Augmented Dickey-Fuller Results, Spotify")
          for i,col in zip(SP e, SP e.columns):
              ad fullerSP = adfuller(SP e[i])
              print(col)
              print(f'ADF Statistic: {ad fullerSP[0]}')
              print(f'p-value: {ad fullerSP[1]}\n')
         Augmented Dickey-Fuller Results, Spotify
         S
         ADF Statistic: -2.2156345064134757
         p-value: 0.20062004609886225
         ADF Statistic: -0.9715781759237457
         p-value: 0.7634888721856858
         EGR
         ADF Statistic: -2.068728698603671
         p-value: 0.2572733859527792
         CPP
         ADF Statistic: -2.144844093972699
         p-value: 0.22686885366652376
```

```
ADF Statistic: -3.562414955438831
         p-value: 0.006521588745435436
         TWF
         ADF Statistic: -2.217067513736407
         p-value: 0.20010935147968678
            # Granger's Causality Matrices for each variable we are interested in,
            isolated by DSP
In []:
In [61]:
          # Source:
              #https://www.machinelearningplus.com/time-series/vector-autoregression-examples-pythol
          from statsmodels.tsa.stattools import grangercausalitytests
          maxlag=12
          test = 'ssr chi2test'
          def grangers causation matrix(data, variables, test='ssr chi2test', verbose=False):
              """Check Granger Causality of all possible combinations of the Time series.
              The rows are the response variable, columns are predictors. The values in the table
              are the P-Values. P-Values lesser than the significance level (0.05), implies
              the Null Hypothesis that the coefficients of the corresponding past values is
              zero, that is, the X does not cause Y can be rejected.
                       : pandas dataframe containing the time series variables
              variables: list containing names of the time series variables.
              df = pd.DataFrame(np.zeros((len(variables), len(variables))), columns=variables, index
              for c in df.columns:
                  for r in df.index:
                      test result = grangercausalitytests(data[[r, c]], maxlag=maxlag, verbose=False
                      p values = [round(test result[i+1][0][test][1],4) for i in range(maxlag)]
                      if verbose: print(f'Y = {r}, X = {c}, P Values = {p values}')
                      min p value = np.min(p values)
                      df.loc[r, c] = min p value
              df.columns = [var + ' x' for var in variables]
              df.index = [var + ' y' for var in variables]
              return df
In [62]:
          print("Granger's Causality Matrix: Apple Music")
          grangers causation matrix(AM e, variables = AM e.columns)
         Granger's Causality Matrix: Apple Music
Out[62]:
                  S_x
                         L_x EGR_x CPP_x
                                          IGR_x TWR_x TWF_x
            S_y 1.0000 0.0836 0.0077
                                    0.0067 0.1089 0.0287 0.1952
            L_y 0.0000 1.0000 0.0000 0.0000 0.2362 0.0823 0.0930
          EGR_y 0.1012 0.0178 1.0000
                                    0.0166 0.1076 0.0384 0.0001
                                    1.0000 0.0956 0.0469 0.0001
          CPP_y 0.0619 0.0084 0.0126
          IGR_y 0.0002 0.0003 0.0604 0.0329 1.0000 0.0000 0.7974
         TWR_y 0.0007 0.0111 0.4613 0.4696 0.0276 1.0000 0.3982
```

TGR

TWR

ADF Statistic: -3.760751013655978 p-value: 0.0033354010072072005

```
In [63]:
          print("Granger's Causality Matrix: SoundCloud")
          grangers causation matrix(SC e, variables = SC e.columns)
         Granger's Causality Matrix: SoundCloud
Out[63]:
                          L_x EGR_x CPP_x IGR_x TWR_x TWF_x
                   S_x
            S_y 1.0000 0.0009 0.1565 0.1749 0.0050 0.1190 0.5848
            L_y 0.0051 1.0000 0.0001 0.0001 0.2209 0.4791 0.0001
          EGR_y 0.6531 0.0000 1.0000
                                     0.0166 0.1076 0.0384
                                                         0.0001
          CPP_y 0.6233 0.0000 0.0126
                                     1.0000 0.0956 0.0469 0.0001
                                            1.0000 0.0000 0.7974
           IGR_y 0.0159 0.1431 0.0604
                                     0.0329
          TWR_y 0.2680 0.2800 0.4613 0.4696 0.0276
                                                  1.0000 0.3982
          TWF_y 0.0006 0.0260 0.0063 0.0019 0.0536 0.0000 1.0000
In [64]:
          print("Granger's Causaility Matrix: Spotify")
          grangers causation matrix(SP e, variables = SP e.columns)
         Granger's Causaility Matrix: Spotify
                                            IGR_x TWR_x TWF_x
Out [64]:
                   S_x
                          L_x EGR_x CPP_x
            S_y 1.0000 0.0000 0.0000 0.0000 0.0431 0.1447 0.0000
            L_y 0.0003 1.0000 0.0001 0.0001 0.0090 0.4626 0.0001
          EGR_y 0.0052 0.0000 1.0000
                                     0.0167 0.1085 0.0385
                                                         0.0001
          CPP_y 0.0042 0.0000 0.0127
                                     1.0000 0.0958 0.0469
                                                         0.0001
           IGR_y 0.0105 0.1431 0.0652 0.0320 1.0000 0.0000 0.8138
          TWR_y 0.5505 0.2804 0.4615 0.4696 0.0283
                                                   1.0000 0.4007
          TWF_y 0.0002 0.0258 0.0064 0.0019 0.0551 0.0000 1.0000
            # Johanon's Cointegration tests for each variable we are interested in,
             isolated by DSP
```

IGR_x TWR_x TWF_x

 S_x

EGR_x CPP_x

TWF_y 0.0000 0.0000 0.0063 0.0019 0.0536 0.0000 1.0000

```
In [65]:
    from statsmodels.tsa.vector_ar.vecm import coint_johansen

def cointegration_test(df, alpha=0.05):
    """Perform Johanson's Cointegration Test and Report Summary"""
    out = coint_johansen(df,-1,5)
    d = {'0.90':0, '0.95':1, '0.99':2}
    traces = out.lr1
    cvts = out.cvt[:, d[str(1-alpha)]]
    def adjust(val, length= 6): return str(val).ljust(length)

# Summary
    print('Name :: Test Stat > C(95%) => Signif \n', '--'*20)
    for col, trace, cvt in zip(df.columns, traces, cvts):
        print(adjust(col), ':: ', adjust(round(trace,2), 9), ">", adjust(cvt, 8), ' => '
```

```
print('Cointegration Test: \nApple Music\n')
In [66]:
          cointegration test(AM e)
         Cointegration Test:
         Apple Music
         Name :: Test Stat > C(95\%) => Signif
          _____
                :: 333.59 > 111.7797 => True
               :: 225.53 > 83.9383 =>
                                                True
         EGR :: 129.45 > 60.0627 =>
                                                True
         CPP :: 73.27 > 40.1749 => True

IGR :: 37.54 > 24.2761 => True

TWR :: 15.96 > 12.3212 => True
         TWF
                :: 6.29
                              > 4.1296 =>
                                                True
In [67]:
          print('Cointegration Test: \nSoundCloud\n')
          cointegration test(SC e)
         Cointegration Test:
         SoundCloud
         Name :: Test Stat > C(95\%) => Signif
           _____
                :: 245.87
                              > 111.7797 => True
                :: 144.38 > 83.9383 =>
                                                True
         EGR :: 85.34 > 60.0627 => True
CPP :: 60.02 > 40.1749 => True
IGR :: 36.7 > 24.2761 => True
TWR :: 17.96 > 12.3212 => True
TWF :: 5.49 > 4.1296 => True
In [68]:
          print('Cointegration Test: \nSpotify\n')
          cointegration test(SP e)
         Cointegration Test:
         Spotify
         Name :: Test Stat > C(95\%) => Signif
           _____
               :: 267.35 > 111.7797 => True
                :: 161.7
                              > 83.9383 => True
         EGR :: 101.7 > 60.3555

EGR :: 102.59 > 60.0627 => True

CPP :: 52.61 > 40.1749 => True

IGR :: 31.66 > 24.2761 => True

TWR :: 14.06 > 12.3212 => True
         TWF
                :: 3.44
                              > 4.1296 =>
                                                False
            # Performing train/test splits on each set of variables we are interested
             in, isolated by DSP
In [69]:
          AM = Data.query("Platform == 'Apple Music'")
          SC = Data.query("Platform == 'SoundCloud'")
```

SP = Data.query("Platform == 'Spotify'")

#AM.head(),SC.head(),SP.head()

AMk = AM.shape[0] SCk = SC.shape[0] SPk = SP.shape[0]

n_sampleAM = int(AMk)
n sampleSC = int(SCk)

```
n \text{ sampleSP} = int(SPk)
#print(n sampleAM)
 #print(n sampleSC)
 #print(n sampleSP)
n trainAM = int(0.90*n sampleAM)+1
n testAM = int(n sampleAM - n trainAM)+1
n forecastAM = n sampleAM - n trainAM
print(f'Apple Music Train: {n trainAM}')
print(f'Apple Music Test: {n testAM}')
print(f'Apple Music Forecast: {n forecastAM}')
n train = int(0.95* 2003)+1
n forecast = n sample - n train
n train
n trainSC = int(0.90*n sampleSC)+1
n testSC = int(n sampleSC - n trainSC)+1
n forecastSC = n sampleSC - n trainSC
print(f'SoundCloud Train: {n trainSC}')
print(f'SoundCloud Test: {n testSC}')
print(f'SoundCloud Forecast: {n forecastSC}')
n trainSP = int(0.90*n sampleSP)+1
n testSP = int(n sampleSP - n trainSP)+1
n forecastSP = n sampleSP - n trainSP
print(f'Spotify Train: {n trainSP}')
print(f'Spotify Test: {n testSP}')
print(f'Spotify Forecast: {n forecastSP}')
ts trainAM = AM[['S','L','EGR','CPP','IGR','TWR','TWF']].iloc[:601]
ts trainSC = SC[['S','L','EGR','CPP','IGR','TWR','TWF']].iloc[:601]
ts trainSP = SP[['S','L','EGR','CPP','IGR','TWR','TWF']].iloc[:600]
ts testAM = AM[['S','L','EGR','CPP','IGR','TWR','TWF']].iloc[601:]
ts testSC = SC[['S','L','EGR','CPP','IGR','TWR','TWF']].iloc[601:]
ts testSP = SP[['S','L','EGR','CPP','IGR','TWR','TWF']].iloc[600:]
ts train = pd.concat([ts trainAM, ts trainSC, ts trainSP])
ts test = pd.concat([ts testAM, ts testSC, ts testSP])
print(ts train.shape)
print(ts test.shape)
print(f'Train.head(): \n{ts train.head()}\n')
print(f'Train.tail(): \n{ts train.tail()}\n')
print(f'Test.head(): \n{ts test.head()}\n')
print(f'Test.tail(): \n{ts test.tail()}\n')
#ts_train = ts_train[['Streams','Listeners','EGR','IGReach','TWR','TWF']]
#ts test = ts test[['Streams','Listeners','EGR','IGReach','TWR','TWF']]
Apple Music Train: 602
Apple Music Test: 67
Apple Music Forecast: 66
SoundCloud Train: 602
SoundCloud Test: 67
SoundCloud Forecast: 66
Spotify Train: 601
Spotify Test: 67
Spotify_Forecast: 66
(1802, 7)
(201, 7)
Train.head():
                         S L EGR CPP IGR TWR TWF
```

Platform Date

```
Apple Music 2020-03-04 7 7 379454 465864 186.250000 0 226
          2020-03-05 58 7 404875 487377 168.500000 0 226
          2020-03-06 59 8 407748 494572 164.666667
                                                   0 227
          2020-03-07 57 4 413262 498931 179.000000 0 227
          2020-03-08 19 5 411552 497810 180.666667 0 227
Train.tail():
                    S L
                             EGR
                                    CPP IGR TWR TWF
Platform Date
Spotify 2021-10-21 2842 1886 155106 178234 0.0
                                               0 367
       2021-10-22 2806 1912 159061 181421 0.0 0 367
       2021-10-23 2895 1858 154096 177380 0.0 0 368
2021-10-24 2602 1735 154098 177339 0.0 0 368
       2021-10-25 2470 1784 169973 193002 0.0 0 367
Test.head():
                     S L EGR
                                   CPP IGR TWR TWF
Platform
         Date
Apple Music 2021-10-26 126 96 90094 106612 0.0 0 366
          2021-10-27 127 92 91363 108366 0.0 0 366
          2021-10-28 147 96 87277 104554 0.0 0 367
          2021-10-29 161 93 86850 103855 243.5 0 367
          2021-10-30 113 84 76326 93772 226.0 0 367
Test.tail():
                   S L EGR
                                    CPP
                                          IGR TWR TWF
Platform Date
Spotify 2021-12-27 5430 4137 131006 160044 291.5 2 381
       2021-12-28 5917 4513 128797 157601 0.0 2 381
       2021-12-29 6479 4782 117195 143391 0.0 2 381
       2021-12-30 5854 4571 116277 142352 0.0 2 381
       2021-12-31 5476 4283 114926 140372 559.0 2 382
```

Performing Augmented Dickey-Fuller Tests on each time-series to check for unit roots, trend-stationarity

```
In [70]:
         def adfuller test(series, signif=0.05, name='', verbose=False):
             """Perform ADFuller to test for Stationarity of given series and print report"""
             r = adfuller(series, autolag='AIC')
             output = {'test statistic':round(r[0], 4), 'pvalue':round(r[1], 4), 'n lags':round(r[2])
             p value = output['pvalue']
             def adjust(val, length= 6): return str(val).ljust(length)
             # Print Summary
             print(f' Augmented Dickey-Fuller Test on "{name}"', "\n ", '-'*47)
             print(f' Null Hypothesis: Data has unit root. Non-Stationary.')
             print(f' Significance Level = {signif}')
             for key, val in r[4].items():
                 print(f' Critical value {adjust(key)} = {round(val, 3)}')
             if p value <= signif:</pre>
                 print(f" => P-Value = {p value}. Rejecting Null Hypothesis.")
                 print(f" => Series is Stationary.")
                 print(f" => P-Value = {p value}. Weak evidence to reject the Null Hypothesis.")
                 print(f" => Series is Non-Stationary.")
```

```
print('\n')
Apple Music, Augmented Dickey-Fuller Test
   Augmented Dickey-Fuller Test on "S"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
                = -4.7232
Test Statistic
No. Lags Chosen
                   = 4
Critical value 1% = -3.441
Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0001. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "L"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -3.5668
No. Lags Chosen
                   = 2
Critical value 1\% = -3.441
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0064. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "EGR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.0469
No. Lags Chosen = 19
Critical value 1\% = -3.442
Critical value 5%
                   = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.2664. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "CPP"
   ______
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.083
No. Lags Chosen = 19
Critical value 1% = -3.442
Critical value 5% = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.2514. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "IGR"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
                   = -3.1834
Test Statistic
No. Lags Chosen
Test Statistic
                   = 17
Critical value 1% = -3.442
Critical value 5% = -2.867
Critical value 10\% = -2.569
```

adfuller test(column, name=column.name)

```
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "TWR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
                = -3.1575
Test Statistic
No. Lags Chosen
                  = 14
Critical value 1%
                  = -3.442
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0226. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "TWF"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.3205
No. Lags Chosen = 0
                  = -3.441
Critical value 1%
Critical value 5%
                  = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.1654. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
print("SoundCloud, Augmented Dickey-Fuller Test")
for name, column in ts trainSC.iteritems():
    adfuller test(column, name=column.name)
   print('\n')
SoundCloud, Augmented Dickey-Fuller Test
   Augmented Dickey-Fuller Test on "S"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
                  = -4.0453
Test Statistic
No. Lags Chosen
                  = 19
Critical value 1% = -3.442
Critical value 5\% = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.0012. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "L"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.2244
No. Lags Chosen
                  = 15
Critical value 1%
                  = -3.442
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.1975. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "EGR"
```

=> P-Value = 0.021. Rejecting Null Hypothesis.

In [72]:

```
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.0469
No. Lags Chosen
                  = 19
Critical value 1\% = -3.442
Critical value 5\% = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.2664. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "CPP"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
                = -2.083
Test Statistic
No. Lags Chosen
                  = 19
Critical value 1%
                  = -3.442
                  = -2.867
Critical value 5%
Critical value 10\% = -2.569
=> P-Value = 0.2514. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
  Augmented Dickey-Fuller Test on "IGR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -3.1834
No. Lags Chosen = 17
Critical value 1\% = -3.442
Critical value 5\% = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.021. Rejecting Null Hypothesis.
=> Series is Stationary.
  Augmented Dickey-Fuller Test on "TWR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -3.1575
No. Lags Chosen = 14
Critical value 1\% = -3.442
Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0226. Rejecting Null Hypothesis.
=> Series is Stationary.
  Augmented Dickey-Fuller Test on "TWF"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic
                  = -2.3205
No. Lags Chosen
                  = 0
Critical value 1% = -3.441
Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.1654. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
```

```
for name, column in ts trainSP.iteritems():
    adfuller test(column, name=column.name)
    print('\n')
Spotify, Augmented Dickey-Fuller Test
   Augmented Dickey-Fuller Test on "S"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic
                   = -2.6058
No. Lags Chosen
                   = 19
Critical value 1\% = -3.442
Critical value 5%
                   = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.0918. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "L"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.2394
No. Lags Chosen
                   = 15
Critical value 1% = -3.442
Critical value 5% = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.1923. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "EGR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.046
                   = 19
No. Lags Chosen
Critical value 1%
                   = -3.442
Critical value 5%
                   = -2.867
Critical value 10\% = -2.569
=> P-Value = 0.2668. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "CPP"
   ______
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -2.0816
No. Lags Chosen = 19
Critical value 1%
                   = -3.442
                   = -2.867
Critical value 5%
Critical value 10\% = -2.569
=> P-Value = 0.252. Weak evidence to reject the Null Hypothesis.
=> Series is Non-Stationary.
   Augmented Dickey-Fuller Test on "IGR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -3.2211
No. Lags Chosen = 14
Critical value 1% = -3.442
Critical value 5% = -2.866
```

```
=> Series is Stationary.
            Augmented Dickey-Fuller Test on "TWR"
             _____
         Null Hypothesis: Data has unit root. Non-Stationary.
          Significance Level = 0.05
         Test Statistic = -3.1578
         No. Lags Chosen
                             = 14
         Critical value 1% = -3.442
Critical value 5% = -2.866
         Critical value 10\% = -2.569
         => P-Value = 0.0226. Rejecting Null Hypothesis.
         => Series is Stationary.
            Augmented Dickey-Fuller Test on "TWF"
             -----
         Null Hypothesis: Data has unit root. Non-Stationary.
         Significance Level = 0.05
         Test Statistic = -2.3112
No. Lags Chosen = 0
         Critical value 1%
                             = -3.441
         Critical value 5%
                             = -2.866
         Critical value 10\% = -2.569
         => P-Value = 0.1684. Weak evidence to reject the Null Hypothesis.
         => Series is Non-Stationary.
           # Some of these Time-Series are not Stationary, let's take the difference
           of them and then check
                ADF test results once more:
In [74]:
         Data['lnD St'] = np.log(Data['S']).diff(periods=1).bfill().ffill()
         Data['lnD Li'] = np.log(Data['L']).diff(periods=1).bfill().ffill()
         Data['InD InR'] = np.log(Data['IGR']).diff(periods=1).bfill().ffill()
         Data['lnD TwF'] = np.log(Data['TWF']).diff(periods=1).bfill().ffill()
         Data['lnD ChC'] = np.log(Data['CPP']).diff(periods=1).bfill().ffill()
         Data['InD ChE'] = np.log(Data['EGR']).diff(periods=1).bfill().ffill()
         Data['D St'] = Data['S'].diff(periods=1).bfill().ffill()
         Data['D Li'] = Data['L'].diff(periods=1).bfill().ffill()
         Data['D InR'] = Data['IGR'].diff(periods=1).bfill().ffill()
         Data['D TwF'] = Data['TWF'].diff(periods=1).bfill().ffill()
         Data['D ChC'] = Data['CPP'].diff(periods=1).bfill().ffill()
         Data['D ChE'] = Data['EGR'].diff(periods=1).bfill().ffill()
         Data.replace([-np.inf, np.inf], np.nan, inplace=True)
         ln Dict = {'lnD St': Data['lnD St'],
                    'lnD Li': Data['lnD Li'],
                    'lnD InR': Data['lnD InR'],
                    'lnD TwF': Data['lnD TwF'],
                    'lnD ChC': Data['lnD ChC']}
```

Critical value 10% = -2.569

ln_Data = pd.DataFrame(ln_Dict)
ln Data.index = Data.index

ln Data = ln Data.bfill().ffill()

=> P-Value = 0.0188. Rejecting Null Hypothesis.

```
result = getattr(ufunc, method) (*inputs, **kwargs)
In [75]:
          ln Data
Out[75]:
                                          InD_Li
                                                         InD_TwF
                                 InD_St
                                                 InD_InR
                                                                  InD_ChC
            Platform
                         Date
         Apple Music 2020-03-04
                               0.045144
                   2020-03-05
                               2.114533
                                       0.000000 -0.100154 0.000000
                                                                 0.045144
                   2020-03-06
                               0.017094
                                        0.133531 -0.023013
                                                        0.004415
                                                                 0.014655
                    2020-03-07 -0.034486 -0.693147 0.083463 0.000000
                                                                 0.008775
                   2020-03-08
                              -1.098612
                                       ...
                                                     ...
                    2021-12-27
                               0.197239
                                        0.225745
            Spotify
                                               -0.113847 0.000000
                                                                 -0.011894
                    2021-12-28
                              0.085890
                                       0.086991
                                                -0.113847
                                                        0.000000
                                                                 -0.015382
                    2021-12-29
                              0.090737
                                        0.057897
                                                        0.000000
                                                -0.113847
                                                                -0.094491
                    2021-12-30
                              -0.101441 -0.045127
                                                -0.113847
                                                        0.000000
                                                                -0.007272
                    2021-12-31 -0.066750 -0.065078 -0.113847 0.002621
        2003 rows × 5 columns
In [76]:
         lnAM = ln Data.query("Platform == 'Apple Music'")
         lnAM = lnAM.bfill().ffill()
         lnSC = ln Data.query("Platform == 'SoundCloud'")
         lnSC = lnSC.bfill().ffill()
         lnSP = ln Data.query("Platform == 'Spotify'")
         lnSP = lnSP.bfill().ffill()
In [77]:
         print("Apple Music, Augmented Dickey-Fuller Test")
         for name, column in lnAM.iteritems():
             adfuller test(column, name=column.name)
             print('\n')
         Apple Music, Augmented Dickey-Fuller Test
             Augmented Dickey-Fuller Test on "lnD St"
             -----
          Null Hypothesis: Data has unit root. Non-Stationary.
          Significance Level = 0.05
         Test Statistic = -10.3603
         No. Lags Chosen
                             = 8
          Critical value 1%
                             = -3.44
                             = -2.866
          Critical value 5%
         Critical value 10%
                              = -2.569
          => P-Value = 0.0. Rejecting Null Hypothesis.
          => Series is Stationary.
             Augmented Dickey-Fuller Test on "InD Li"
                   -----
          Null Hypothesis: Data has unit root. Non-Stationary.
          Significance Level = 0.05
                              = -9.0894
          Test Statistic
          No. Lags Chosen
                              = 11
```

ivide by zero encountered in log

```
Critical value 1\% = -3.44
Critical value 5%
                    = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "InD InR"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
 Significance Level = 0.05
Test Statistic = -5.5832

No. Lags Chosen = 3

Critical value 1% = -3.44
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "InD TwF"
    _____
 Null Hypothesis: Data has unit root. Non-Stationary.
 Significance Level = 0.05
                 = -4.2629
Test Statistic
No. Lags Chosen
                    = 19
Critical value 1% = -3.44
Critical value 5% = -2.866
Critical value 10\% = -2.569
 => P-Value = 0.0005. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD ChC"
    _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -8.4517
                    = 18
No. Lags Chosen
Critical value 1%
                    = -3.44
Critical value 5%
                    = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
print("SoundCloud, Augmented Dickey-Fuller Test")
for name, column in lnSC.iteritems():
    adfuller test(column, name=column.name)
    print('\n')
SoundCloud, Augmented Dickey-Fuller Test
   Augmented Dickey-Fuller Test on "lnD St"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -15.5951
No. Lags Chosen = 3
Critical value 1% = -3.44
Critical value 5% = -2.866
Critical value 10% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
```

In [78]:

```
Augmented Dickey-Fuller Test on "InD Li"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -5.9224

No. Lags Chosen = 20

Critical value 1% = -3.44

Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD InR"
    _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic
No. Lags Chosen
                    = -5.6107
                   = 3
Critical value 1% = -3.44
Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD TwF"
    _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
                = -4.7729
Test Statistic
No. Lags Chosen
                    = 19
Critical value 1\% = -3.44
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0001. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD ChC"
    _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -8.4138
No. Lags Chosen
                   = 18
Critical value 1\% = -3.44
Critical value 5%
                   = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
print("Spotify, Augmented Dickey-Fuller Test")
for name, column in lnSP.iteritems():
    adfuller test(column, name=column.name)
    print('\n')
Spotify, Augmented Dickey-Fuller Test
   Augmented Dickey-Fuller Test on "InD St"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -12.5365
```

In [79]:

```
No. Lags Chosen = 7
Critical value 1\% = -3.44
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD Li"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -6.2093

No. Lags Chosen = 20

Critical value 1% = -3.441

Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD InR"
   -----
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -9.645

No. Lags Chosen = 1

Critical value 1% = -3.44

Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD TwF"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -4.7606
No. Lags Chosen
                    = 19
Critical value 1% = -3.44
Critical value 5% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0001. Rejecting Null Hypothesis.
=> Series is Stationary.
   Augmented Dickey-Fuller Test on "lnD ChC"
   _____
Null Hypothesis: Data has unit root. Non-Stationary.
Significance Level = 0.05
Test Statistic = -8.4037
No. Lags Chosen = 18
Critical value 1\% = -3.44
Critical value 5\% = -2.866
Critical value 10\% = -2.569
=> P-Value = 0.0. Rejecting Null Hypothesis.
=> Series is Stationary.
```

NOTE: The log-differenced data appears to be more stationary across the board as compared to the earlier Augmented Dickey-Fuller Results of the non-transformed data.

Apple Music, VAR Estimation:

```
In [80]:
         # make a VAR model
         # Vector Autoregression Model
         # VAR(p) processes
         # See Wooldridge p. 626 for a discussion of VAR models.
         # It should be noted that much financial timeseries data are non-stationary.
         # Before any analysis it is a good idea to plot the data, test for unit roots, and probabl
         # construct the log-differences in the data to obtain % return that are almost always state
         # In the code above, I have constructed the log-differenced data for the etf funds.
         # We are interested in modeling a T×K
         # multivariate time series Y, where T denotes the number of observations
         # and K the number of variables. One way of estimating relationships
         # between the time series and their lagged values is the vector autoregression process:
         # Yt = v + A1 Yt-1 + ... + Ap Yt-p + ut where ut~Normal(0,\Sigmau) and A is a K×K coefficient me
         # see https://www.statsmodels.org/dev/vector ar.html
         var modelAM = VAR(lnAM)
         resultsAM = var modelAM.fit()
         print(f'resultsAM.summary():\n{resultsAM.summary()}\n')
         resultsAM.plot()
         resultsAM.plot acorr()
        resultsAM.summary():
          Summary of Regression Results
        _____
        Model:
        Method:
                     Wed, 09, Feb, 2022
                              14:46:59
        No. of Equations: 5.00000 BIC:
                                                              -22.9775
                              667.000 HQIC:
                              3028.38 FPE:
        Log likelihood:
                                                           8.57122e-11
                              -23.1800 Det(Omega mle): 8.19590e-11
        ATC:
        ______
        Results for equation lnD St
        ______
                      coefficient std. error t-stat
                                   0.015544
0.059296
0.077844
0.053276
4.854209
0.066990
                        0.003497
                                                          0.225
        L1.lnD St
                      -0.166957
                                                        -2.816
                                                         0.232
        L1.lnD Li
                       0.018056
                       -0.070031
        L1.lnD InR
                                                        -1.314
                                                                        0.189
        L1.lnD TwF
                        -0.115503
                                                         -0.024
                    -0.055748
        L1.lnD ChC
                                                         -0.832
        ______
        Results for equation lnD Li
        ______
                                   std. error
                      coefficient
                                                        t-stat
        ______

      0.001406
      0.011985

      0.035700
      0.045720

      -0.242497
      0.060021

      -0.046572
      0.041078

      -0.360971
      3.742806

      -0.082395
      0.051652

        const
                                                          0.117
                                                                         0.907
        L1.lnD St
                                                         0.781
                                                        -4.040
        L1.lnD Li
        L1.lnD InR
                                                         -1.134
```

Results for equation lnD InR ______

-0.096

-1.595

L1.lnD TwF

L1.lnD ChC

	coefficient	std. error	t-stat	prob
const	-0.030563	0.008976	-3.405	0.001
L1.lnD_St	-0.046902	0.034241	-1.370	0.171
L1.lnD_Li	0.039511	0.044952	0.879	0.379
L1.lnD_InR	0.625537	0.030765	20.333	0.000
L1.lnD_TwF	3.223425	2.803107	1.150	0.250
L1.lnD_ChC	0.031032	0.038684	0.802	0.422
==========				========

Results for equation lnD TwF

=========				
	coefficient	std. error	t-stat	prob
const	0.000715	0.000124	5.745	0.000
L1.lnD St	0.000630	0.000475	1.329	0.184
L1.lnD Li	-0.000215	0.000623	-0.345	0.730
L1.lnD InR	-0.000476	0.000426	-1.116	0.265
L1.lnD TwF	0.039666	0.038846	1.021	0.307
L1.lnD_ChC	-0.000898	0.000536	-1.675	0.094
==========				

Results for equation lnD ChC

==========				
	coefficient	std. error	t-stat	prob
const	-0.003299	0.008763	-0.376	0.707
L1.lnD_St	0.006802	0.033430	0.203	0.839
L1.lnD_Li	0.005668	0.043887	0.129	0.897
L1.lnD_InR	-0.008013	0.030036	-0.267	0.790
L1.lnD_TwF	0.534147	2.736715	0.195	0.845
L1.lnD_ChC	-0.242485	0.037768	-6.420	0.000

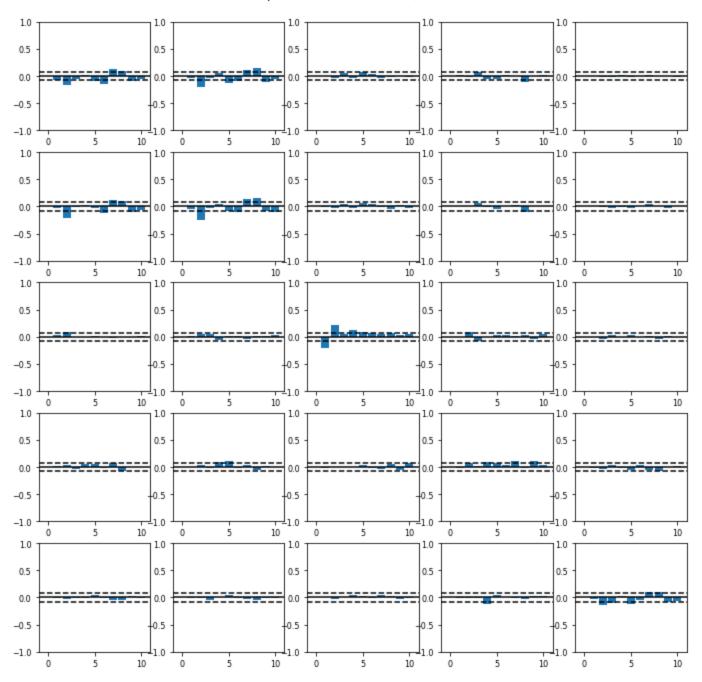
Correlation matrix of residuals

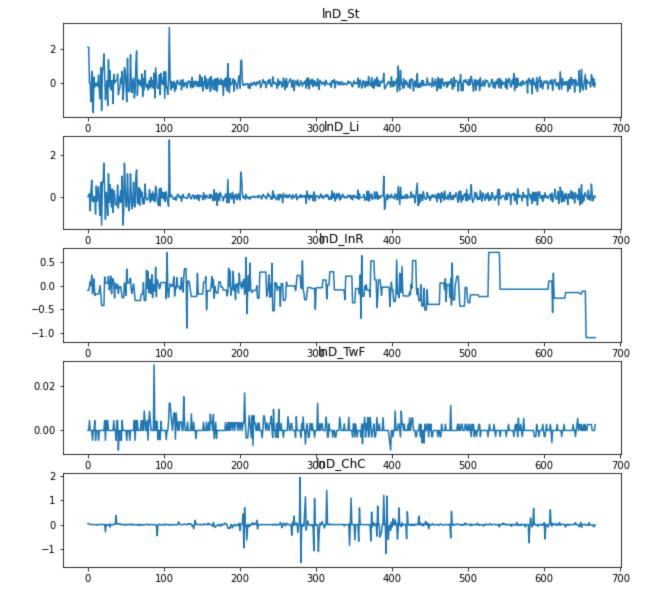
	lnD_St	lnD_Li	lnD_InR	lnD_TwF	lnD_ChC
lnD_St	1.000000	0.798351	-0.012173	0.098076	0.031564
lnD_Li	0.798351	1.000000	0.004503	0.097270	0.026902
lnD_InR	-0.012173	0.004503	1.000000	0.046996	-0.006647
lnD_TwF	0.098076	0.097270	0.046996	1.000000	-0.008008
lnD ChC	0.031564	0.026902	-0.006647	-0.008008	1.000000

/opt/anaconda3/lib/python3.8/site-packages/statsmodels/tsa/base/tsa_model.py:590: ValueWar ning: An unsupported index was provided and will be ignored when e.g. forecasting. warnings.warn('An unsupported index was provided and will be'

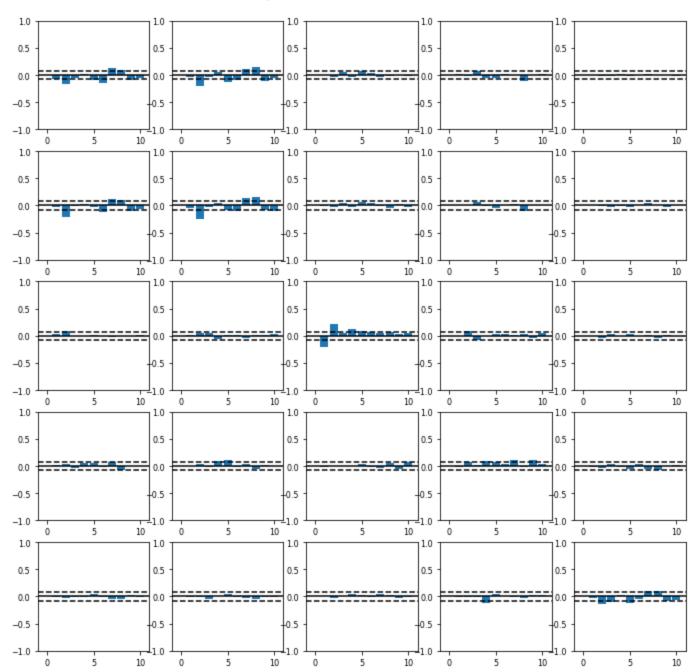
Out[80]:

ACF plots for residuals with $2/\sqrt{T}$ bounds



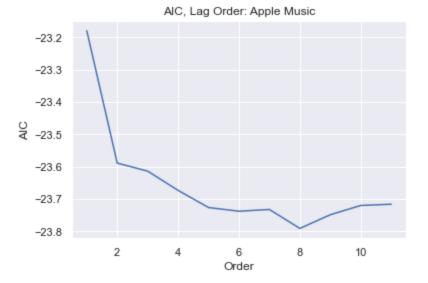


ACF plots for residuals with $2/\sqrt{T}$ bounds



```
In [84]:
    resultsAM_aic = []
    for p in range(1,12):
        resultsAM = var_modelAM.fit(p)
        resultsAM_aic.append(resultsAM.aic)

    import seaborn as sns
    sns.set()
    plt.title('AIC, Lag Order: Apple Music')
    plt.plot(list(np.arange(1,12,1)), resultsAM_aic)
    plt.xlabel("Order")
    plt.ylabel("AIC")
    plt.show()
```



Lowest AIC occurs at approx. (Order8, AIC-23.8)

```
In [85]:
          # Lag order selection
          # Choice of lag order can be a difficult problem.
          # Standard analysis employs likelihood test or information criteria-based order selection
          # We have implemented the latter, accessible through the VAR class:
          # When calling the fit function, one can pass a maximum number of lags
          # and the order criterion to use for order selection:
         var modelAM.select order(8)
         resultsAMs = var modelAM.fit(maxlags=8, ic='aic')
         print(f'resultsAMs.summary():\n{resultsAMs.summary()}\n')
         resultsAMs.summary():
           Summary of Regression Results
         _____
```

Model: VAR OLS Method: Date: Wed, 09, Feb, 2022 Time: 14:48:24

5.00000 BIC: No. of Equations: -22.8448 663.000 HQIC: Nobs: -23.3848 Log likelihood: 3291.54 FPE: 4.96376e-11 -23.7265 Det(Omega mle): AIC: 4.09527e-11

Results for equation lnD St

______ coefficient std. error t-stat const 0.002207 0.015930 0.139 0.890 0.000 L1.lnD St -0.333742 0.071592 -4.662 L1.lnD Li 0.090096 1.033 0.093105 0.301 0.067968 4.581397 0.065664 0.076947 0.097334 L1.lnD InR -0.164055 -2.414 0.016 L1.lnD TwF 4.500472 0.982 0.326 -0.071057 L1.lnD ChC -1.082 0.279 -0.086975 L2.lnD St -1.130 0.258 -2.155 L2.lnD Li -0.209766 0.031 L2.lnD InR 0.002514 0.034 0.973 L2.lnD TwF 1.562049 4.558150 0.343 0.732 0.068127 0.076646 L2.lnD ChC -0.046135 -0.677 0.498 -0.059 L3.1nD St -0.004492 0.953 L3.lnD Li -0.178880 0.098269 -1.820 0.069 L3.lnD InR 0.062961 0.075723 0.831 0.406 11.803717 4.579774 2.577 0.010 L3.1nD TwF

L3.lnD_ChC	-0.071754	0.067955	-1.056	0.291
L4.lnD_St	-0.067689	0.067001	-1.010	0.312
L4.lnD_Li	0.035470	0.088317	0.402	0.688
L4.lnD_InR	-0.071479	0.072264	-0.989	0.323
L4.lnD_TwF	-5.580060	4.585804	-1.217	0.224
L4.lnD_ChC	0.001710	0.067858	0.025	0.980
L5.lnD_St	0.057861	0.057849	1.000	0.317
L5.lnD_Li	-0.219685	0.077895	-2.820	0.005
L5.lnD_InR	0.138306	0.068117	2.030	0.042
L5.lnD_TwF	-8.143492	4.611793	-1.766	0.077
L5.lnD_ChC	-0.034884	0.065308	-0.534	0.593

Results for equation lnD_Li

=========				
	coefficient	std. error	t-stat	prob
	0 000471	0 010631	0.037	0.070
const	0.000471	0.012631	0.037	0.970
L1.lnD_St	0.136474	0.056766	2.404	0.016
L1.lnD_Li	-0.439898	0.071437	-6.158	0.000
L1.lnD_InR	-0.099410	0.053892	-1.845	0.065
L1.lnD_TwF	2.397368	3.632606	0.660	0.509
L1.lnD_ChC	-0.090818	0.052065	-1.744	0.081
L2.lnD_St	0.129453	0.061011	2.122	0.034
L2.lnD_Li	-0.450109	0.077176	-5.832	0.000
L2.lnD_InR	-0.014431	0.058154	-0.248	0.804
L2.lnD TwF	2.618021	3.614173	0.724	0.469
L2.lnD ChC	-0.039884	0.054018	-0.738	0.460
L3.lnD St	0.117919	0.060773	1.940	0.052
L3.lnD Li	-0.293311	0.077918	-3.764	0.000
L3.lnD InR	0.019771	0.060041	0.329	0.742
L3.lnD TwF	7.516511	3.631319	2.070	0.038
L3.lnD ChC	-0.057304	0.053882	-1.064	0.288
L4.lnD St	0.040298	0.053125	0.759	0.448
L4.lnD Li	-0.108158	0.070027	-1.545	0.122
L4.lnD InR	-0.030438	0.057299	-0.531	0.595
L4.lnD TwF	-1.332743	3.636101	-0.367	0.714
L4.lnD ChC	-0.028440	0.053805	-0.529	0.597
L5.lnD St	0.149388	0.045869	3.257	0.001
L5.lnD Li	-0.259054	0.061763	-4.194	0.000
L5.lnD InR	0.111860	0.054010	2.071	0.038
L5.lnD TwF	-4.212507	3.656707	-1.152	0.249
L5.lnD_ChC	-0.050251	0.051783	-0.970	0.332
L5.lnD_ChC	-0.050251	0.051783	-0.970	0.33

Results for equation lnD_InR

	coefficient	std. error	t-stat	prob
const	-0.018119	0.009286	-1.951	0.051
L1.lnD St	-0.012425	0.041730	-0.298	0.766
L1.lnD Li	0.025246	0.052516	0.481	0.631
L1.lnD InR	0.396740	0.039618	10.014	0.000
L1.lnD TwF	3.609518	2.670440	1.352	0.176
L1.lnD_ChC	0.010000	0.038275	0.261	0.794
L2.lnD_St	0.106742	0.044851	2.380	0.017
L2.lnD_Li	-0.082794	0.056735	-1.459	0.144
L2.lnD_InR	0.303278	0.042751	7.094	0.000
L2.lnD_TwF	5.818522	2.656889	2.190	0.029
L2.lnD_ChC	-0.039724	0.039711	-1.000	0.317
L3.lnD_St	-0.011275	0.044676	-0.252	0.801
L3.lnD_Li	0.062792	0.057280	1.096	0.273
L3.lnD_InR	0.030037	0.044138	0.681	0.496
L3.lnD_TwF	-5.401066	2.669494	-2.023	0.043
L3.lnD_ChC	0.015569	0.039610	0.393	0.694
L4.lnD_St	0.032930	0.039054	0.843	0.399

L4.lnD_Li	-0.048070	0.051479	-0.934	0.350
L4.lnD_InR	0.059594	0.042122	1.415	0.157
L4.lnD_TwF	-2.689583	2.673009	-1.006	0.314
L4.lnD_ChC	0.017476	0.039554	0.442	0.659
L5.lnD_St	0.055518	0.033720	1.646	0.100
L5.lnD_Li	-0.055779	0.045404	-1.229	0.219
L5.lnD_InR	0.028861	0.039705	0.727	0.467
L5.lnD_TwF	0.676601	2.688157	0.252	0.801
L5.lnD_ChC	0.018827	0.038067	0.495	0.621

Results for equation lnD_TwF

==========	=======================================		===============	
	coefficient	std. error	t-stat	prob
const	0.000584	0.000137	4.266	0.000
L1.lnD St	0.000555	0.000615	0.902	0.367
L1.lnD Li	-0.000062	0.000774	-0.080	0.936
L1.lnD InR	-0.000692	0.000584	-1.185	0.236
L1.lnD TwF	0.016121	0.039381	0.409	0.682
L1.lnD ChC	-0.000828	0.000564	-1.466	0.143
L2.1nD St	0.000356	0.000661	0.538	0.591
L2.lnD Li	0.000272	0.000837	0.325	0.745
L2.lnD_InR	-0.000148	0.000630	-0.235	0.814
L2.lnD_TwF	0.065212	0.039181	1.664	0.096
L2.lnD_ChC	-0.000426	0.000586	-0.727	0.467
L3.lnD_St	-0.000417	0.000659	-0.632	0.527
L3.lnD_Li	0.000734	0.000845	0.868	0.385
L3.lnD_InR	0.000188	0.000651	0.290	0.772
L3.lnD_TwF	0.016911	0.039367	0.430	0.668
L3.lnD_ChC	0.000323	0.000584	0.553	0.580
L4.lnD_St	-0.000665	0.000576	-1.154	0.248
L4.lnD_Li	0.001828	0.000759	2.408	0.016
L4.lnD_InR	0.000053	0.000621	0.085	0.932
L4.lnD_TwF	0.077761	0.039418	1.973	0.049
L4.lnD_ChC	-0.000007	0.000583	-0.012	0.990
L5.lnD_St	-0.000817	0.000497	-1.644	0.100
L5.lnD_Li	0.002264	0.000670	3.381	0.001
L5.lnD_InR	0.000506	0.000586	0.864	0.387
L5.lnD_TwF	0.048656	0.039642	1.227	0.220
L5.lnD_ChC	-0.000778	0.000561	-1.385	0.166

Results for equation lnD_ChC

	· <u> </u>			
	coefficient	std. error	t-stat	prob
const	0.003328	0.009510	0.350	0.726
L1.lnD St	-0.000245	0.042741	-0.006	0.995
L1.lnD Li	0.007530	0.053788	0.140	0.889
L1.lnD InR	-0.052880	0.040577	-1.303	0.193
L1.lnD TwF	-0.338182	2.735116	-0.124	0.902
L1.lnD ChC	-0.287122	0.039202	-7.324	0.000
L2.1nD St	-0.030760	0.045938	-0.670	0.503
L2.lnD Li	0.028519	0.058109	0.491	0.624
L2.lnD InR	-0.029952	0.043786	-0.684	0.494
L2.lnD TwF	0.402669	2.721238	0.148	0.882
L2.lnD_ChC	-0.174014	0.040672	-4.278	0.000
L3.lnD_St	0.059495	0.045758	1.300	0.194
L3.lnD_Li	-0.080755	0.058667	-1.376	0.169
L3.lnD_InR	0.035243	0.045207	0.780	0.436
L3.lnD_TwF	-1.182716	2.734147	-0.433	0.665
L3.lnD_ChC	-0.160354	0.040570	-3.953	0.000
L4.lnD_St	0.015179	0.04000	0.379	0.704
L4.lnD_Li	-0.010626	0.052726	-0.202	0.840
L4.lnD_InR	0.064543	0.043142	1.496	0.135

```
L4.lnD_TwF
      -8.471797 2.737747
                        -3.094
                                0.002
-0.790
                               0.429
                        0.445
                               0.656
                        0.333
                               0.739
                               0.773
                        0.289
                        1.083
                               0.279
L5.lnD ChC -0.131875 0.038989 -3.382
______
```

Correlation matrix of residuals

Forecasts: Apple Music

lnD_St lnD_Li lnD_InR lnD_TwF lnD_ChC [1.35074608 0.40012197 4.56204155 0.04256127 0.77532582]

```
        lnD_St
        lnD_Li
        lnD_InR
        lnD_TwF
        lnD_ChC

        lnD_St
        1.000000
        0.838346
        -0.001781
        0.144712
        0.016743

        lnD_Li
        0.838346
        1.000000
        0.015307
        0.132774
        0.016169

        lnD_InR
        -0.001781
        0.015307
        1.000000
        0.040911
        -0.015565

        lnD_TwF
        0.144712
        0.132774
        0.040911
        1.000000
        -0.014769

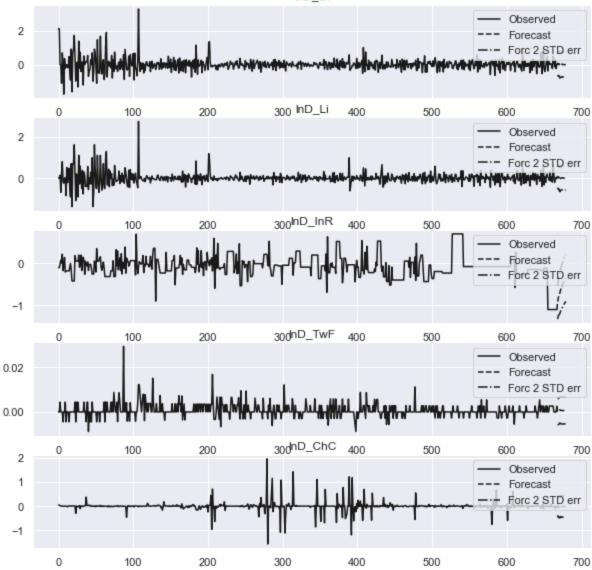
        lnD_ChC
        0.016743
        0.016169
        -0.015565
        -0.014769
        1.000000
```

```
In [86]:
         # Forecasting
          # The linear predictor is the optimal h-step ahead forecast in terms of mean-squared erro
          \# yt(h) = v + A1 yt(h-1) + \cdots + Ap yt(h-p)
          # We can use the forecast function to produce this forecast.
          # Note that we have to specify the "initial value" for the forecast:
         lag orderAM = resultsAM.k ar
         forecastAM = resultsAM.forecast(resultsAMs.params.to numpy(), 12)
         print(f'forecastAM:\n{forecastAM}\n')
         print('Forecasts: Apple Music')
         print(' lnD St lnD Li lnD InR lnD TwF lnD ChC ')
         print(np.sum(forecastAM, axis=0))
         forecastAM:
         [ 1.20789227e+00 5.07864648e-01 2.75532426e-01 5.31786196e-03
          -5.42139478e-01]
          [ 2.50654165e-01 -3.03410134e-01 4.33508646e-01 1.40652575e-02
          -6.67119340e-01]
          [ 8.19293619e-01 1.26489439e+00 2.24920684e-01 1.61737193e-02
           4.82335160e-01]
          [ 2.51369292e-01 -3.57653290e-01 5.25715908e-01 -3.34866397e-03
           6.34082275e-01]
          [ 1.37411390e-01 -4.76994796e-03 3.93631536e-01 5.73328906e-03
           1.34233015e+00]
          [-1.00926924e+00 -5.00576721e-01 8.13789850e-01 -2.58118460e-03
          -5.89041494e-02]
          [-1.14195076e+00 -8.28709772e-01 4.71554954e-01 8.76854182e-04]
           1.63273567e-01]
          [ 5.60944655e-01 4.90736412e-01 4.10267513e-01 5.53205183e-03
          -4.95800256e-01]
          [ 1.10809279e-01 1.08858864e-01 5.94301287e-01 5.24883896e-03
          -1.68674662e-01]
          [-3.90377116e-01 -2.81172965e-01 1.88133108e-01 -6.15582995e-03
           -1.44721708e-01]
          [ 2.87518446e-01 1.01324977e-01 2.27566877e-01 -2.20574091e-04
           1.01932604e-01]
          [ 2.66450076e-01 2.02735502e-01 3.11876007e-03 1.91965263e-03
           1.28731653e-01]]
```

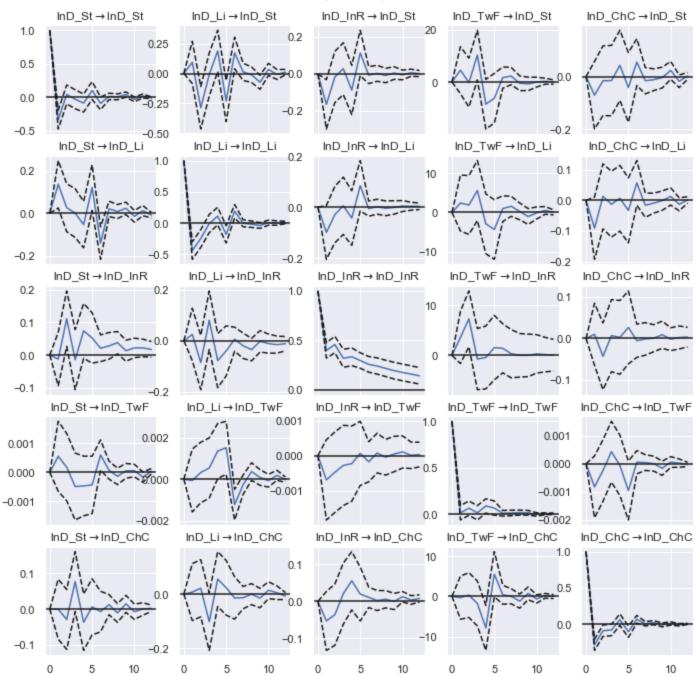
```
In [89]:
         # The forecast interval function will produce the above forecast along with asymptotic sta
         # These can be visualized using the plot forecast function:
         resultsAMs.plot forecast(12)
         # Impulse Response Analysis
         # Impulse responses are of interest in econometric studies:
         # they are the estimated responses to a unit impulse in one of the variables.
         # They are computed in practice using the MA(\infty) representation of the VAR(p) process:
         # Yt = \mu + \sum_{i=0}^{\infty} to \infty \Phi_i ut^{-i}
         # We can perform an impulse response analysis by calling the irf function on a VARResults
         # These can be visualized using the plot function, in either orthogonalized or non-orthogo
         # Asymptotic standard errors are plotted by default at the 95% significance level, which
         irf = resultsAMs.irf(12)
         irf.plot(orth=False)
         # The cumulative effects \Psi n = \sum ni = 0\Phi i can be plotted with the long run effects as follows:
         irf.plot cum effects(orth=False)
         # Granger causality
         # One is often interested in whether a variable or group of variables is "causal" for ano
         # for some definition of "causal". In the context of VAR models,
         # one can say that a set of variables are Granger-causal within one of the VAR equations.
         # See Wooldridge p. 626 for a discussion of Granger causality.
         # The VARResults object has the test causality method
         # for performing either a Wald (\chi2) test or an F-test.
         print('Test for Granger causality for Streams\n')
         print(resultsAMs.test_causality('lnD_St', ['lnD_Li', 'lnD InR','lnD TwF','lnD ChC'], kind=
         print('Test for Granger causality for IGReach\n')
         print(resultsAMs.test causality('lnD InR', ['lnD St', 'lnD Li', 'lnD TwF', 'lnD ChC'], kind=
         # Normality
         # The white noise component ut is assumed to be normally distributed.
         # While this assumption is not required for parameter estimates to be consistent or asymptotic
         # results are generally more reliable in finite samples when residuals are Gaussian white
         # To test whether this assumption is consistent with a data set, VARResults offers the tes
         # Note: Stock market return data are frequently NOT normally distributed!
         print(resultsAMs.test normality())
        Test for Granger causality for Streams
        <statsmodels.tsa.vector ar.hypothesis test results.CausalityTestResults object. H 0: ['lnD</pre>
         Li', 'lnD InR', 'lnD TwF', 'lnD ChC'] do not Granger-cause lnD St: reject at 5% significa
        nce level. Test statistic: 2.300, critical value: 1.574>, p-value: 0.001>
        Test for Granger causality for IGReach
        <statsmodels.tsa.vector ar.hypothesis test results.CausalityTestResults object. H 0: ['lnD</pre>
         _St', 'lnD_Li', 'lnD_TwF', 'lnD_ChC'] do not Granger-cause lnD InR: reject at 5% significa
        nce level. Test statistic: 1.713, critical value: 1.574>, p-value: 0.025>
```

<statsmodels.tsa.vector_ar.hypothesis_test_results.NormalityTestResults object. H_0: data
generated by normally-distributed process: reject at 5% significance level. Test statisti</pre>

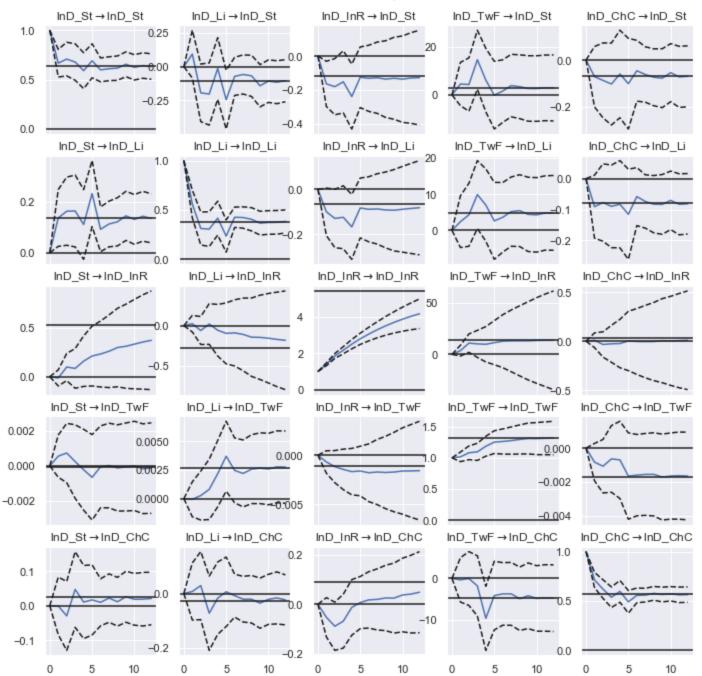
c: 28663.622, critical value: 18.307>, p-value: 0.000>



Impulse responses



Cumulative responses



SoundCloud, VAR Estimation:

```
In [90]:
```

- # make a VAR model
- # Vector Autoregression Model
- # VAR(p) processes
- # See Wooldridge p. 626 for a discussion of VAR models.
- # It should be noted that much financial timeseries data are non-stationary.
- # Before any analysis it is a good idea to plot the data, test for unit roots, and probabl
- # construct the log-differences in the data to obtain % return that are almost always stat
- # In the code above, I have constructed the log-differenced data for the etf funds.
- # We are interested in modeling a T×K
- # multivariate time series Y, where T denotes the number of observations
- # and K the number of variables. One way of estimating relationships
- # between the time series and their lagged values is the vector autoregression process:
- # Yt = v + Al Yt-1 + ... + Ap Yt-p + ut where ut~Normal(0, Σ u) and A is a K×K coefficient me
- # see https://www.statsmodels.org/dev/vector ar.html

```
var modelSC = VAR(lnSC)
resultsSC = var modelSC.fit()
print(f'resultsSC.summary():\n{resultsSC.summary()}\n')
resultsSC.plot()
resultsSC.plot acorr()
/opt/anaconda3/lib/python3.8/site-packages/statsmodels/tsa/base/tsa model.py:590: ValueWar
ning: An unsupported index was provided and will be ignored when e.g. forecasting.
 warnings.warn('An unsupported index was provided and will be'
resultsSC.summary():
 Summary of Regression Results
```

Model: VAR Method: OLS Date: Wed, 09, Feb, 2022 14:52:05

No. of Equations: 5.00000 BIC: -22.1054Nobs: 667.000 HQIC: -22.2295 2737.54 FPE: Log likelihood: 2.05015e-10 -22.3079 Det(Omega_mle): 1.96037e-10 AIC:

Results for equation lnD St

	coefficient	std. error	t-stat	prob
const	0.000653	0.014961	0.044	0.965
L1.lnD St	0.008953	0.038811	0.231	0.818
L1.lnD Li	0.001546	0.053252	0.029	0.977
L1.lnD InR	-0.047559	0.052889	-0.899	0.369
L1.lnD TwF	-1.090155	0.749148	-1.455	0.146
L1.lnD_ChC	-0.060268	0.066372	-0.908	0.364

Results for equation lnD Li

=========				
	coefficient	std. error	t-stat	prob
const	0.007355	0.010857	0.677	0.498
L1.lnD_St	0.047354	0.028163	1.681	0.093
L1.lnD Li	-0.057146	0.038642	-1.479	0.139
L1.lnD InR	0.000746	0.038379	0.019	0.984
L1.lnD TwF	-0.943653	0.543618	-1.736	0.083
L1.lnD_ChC	0.016310	0.048163	0.339	0.735

Results for equation lnD InR

==========	============		===========	========
	coefficient	std. error	t-stat	prob
const	-0.027474	0.008729	-3.147	0.002
L1.lnD St	-0.000081	0.022645	-0.004	0.997
L1.lnD_Li	0.033394	0.031071	1.075	0.282
L1.lnD_InR	0.627875	0.030859	20.347	0.000
L1.lnD_TwF	-1.095405	0.437103	-2.506	0.012
L1.lnD_ChC	0.031212	0.038726	0.806	0.420
==========				

Results for equation lnD TwF

	coefficient	std. error	t-stat	prob
const	0.000750	0.000121	6.199	0.000
L1.lnD_St	0.000294	0.000314	0.938	

L1.lnD_Li	0.000216	0.000431	0.502	0.616
L1.lnD_InR	-0.000485	0.000428	-1.133	0.257
L1.lnD_TwF	-0.000060	0.006057	-0.010	0.992
L1.lnD_ChC	-0.000845	0.000537	-1.575	0.115

Results for equation lnD_ChC

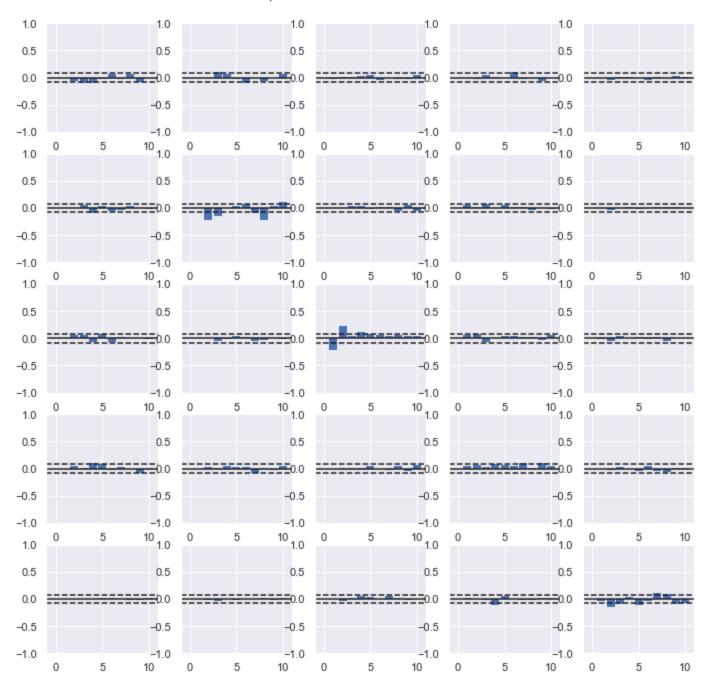
=========				
	coefficient	std. error	t-stat	prob
const	-0.002441	0.008498	-0.287	0.774
L1.lnD St	0.016842	0.022045	0.764	0.445
L1.lnD Li	0.023630	0.030247	0.781	0.435
L1.lnD InR	-0.006857	0.030042	-0.228	0.819
L1.lnD TwF	-0.714745	0.425523	-1.680	0.093
L1.lnD_ChC	-0.241659	0.037700	-6.410	0.000

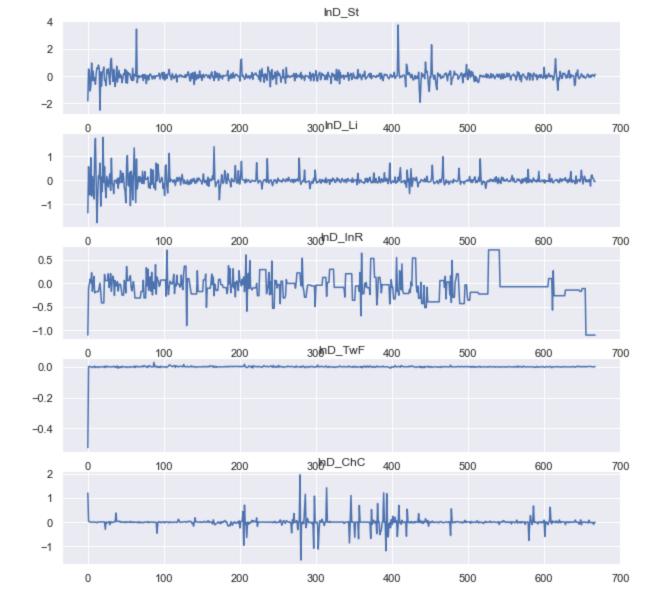
Correlation matrix of residuals

	lnD_St	lnD_Li	lnD_InR	lnD_TwF	lnD_ChC
lnD_St	1.000000	0.022592	-0.008506	0.002647	-0.017425
lnD_Li	0.022592	1.000000	-0.059154	-0.060409	0.033501
lnD_InR	-0.008506	-0.059154	1.000000	0.045228	-0.007489
lnD_TwF	0.002647	-0.060409	0.045228	1.000000	-0.007683
lnD_ChC	-0.017425	0.033501	-0.007489	-0.007683	1.000000

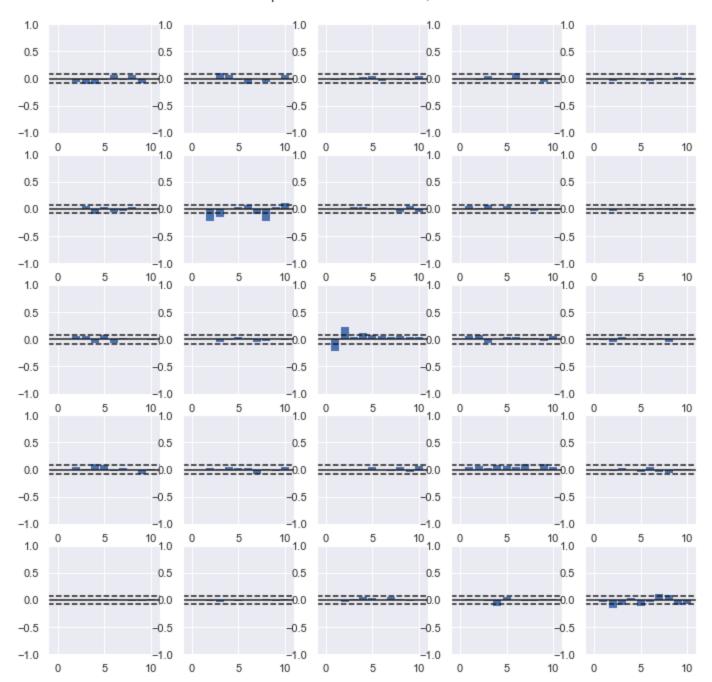
Out[90]:

ACF plots for residuals with $2/\sqrt{T}$ bounds



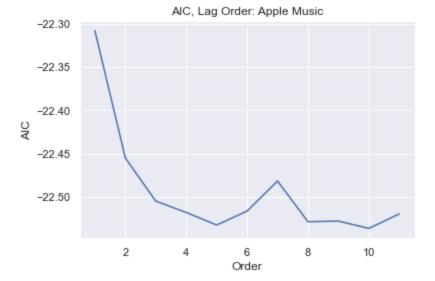


ACF plots for residuals with $2/\sqrt{T}$ bounds



```
In [91]:
    resultsSC_aic = []
    for p in range(1,12):
        resultsSC = var_modelSC.fit(p)
        resultsSC_aic.append(resultsSC.aic)

    import seaborn as sns
    sns.set()
    plt.title('AIC, Lag Order: Apple Music')
    plt.plot(list(np.arange(1,12,1)), resultsSC_aic)
    plt.xlabel("Order")
    plt.ylabel("AIC")
    plt.show()
```



Lowest AIC appears to occur at approximately (Order10, AIC-22.50)

```
In [100... # Lag order selection
# Choice of lag order can be a difficult problem.
# Standard analysis employs likelihood test or information criteria-based order selection.
# We have implemented the latter, accessible through the VAR class:

# When calling the fit function, one can pass a maximum number of lags
# and the order criterion to use for order selection:
var_modelSC.select_order(10)
resultsSCs = var_modelSC.fit(maxlags=10, ic='aic')
print(f'resultsSCs.summary():\n{resultsSCs.summary()}\n')
resultsSCs.summary():
```

Summary of Regression Results

Model: VAR
Method: OLS
Date: Wed, 09, Feb, 2022
Time: 15:00:24

No. of Equations: 5.00000 BIC: -21.8066
Nobs: 664.000 HQIC: -22.2423
Log likelihood: 2870.09 FPE: 1.66195e-10
AIC: -22.5180 Det(Omega_mle): 1.42234e-10

Results for equation lnD St

-==========	-==========		========
coefficient	std. error	t-stat	prob
0.002051	0.016135	0.127	0.899
-0.021634	0.038986	-0.555	0.579
0.033627	0.055594	0.605	0.545
-0.076404	0.071034	-1.076	0.282
-2.431470	4.768416	-0.510	0.610
-0.062196	0.068599	-0.907	0.365
-0.071144	0.038521	-1.847	0.065
0.000536	0.054713	0.010	0.992
0.025494	0.075619	0.337	0.736
-2.282991	4.767552	-0.479	0.632
-0.063400	0.070802	-0.895	0.371
-0.097049	0.038527	-2.519	0.012
0.156864	0.054433	2.882	0.004
0.028806	0.075874	0.380	0.704
5.676889	4.786808	1.186	0.236
	0.002051 -0.021634 0.033627 -0.076404 -2.431470 -0.062196 -0.071144 0.000536 0.025494 -2.282991 -0.063400 -0.097049 0.156864 0.028806	0.002051 0.016135 -0.021634 0.038986 0.033627 0.055594 -0.076404 0.071034 -2.431470 4.768416 -0.062196 0.068599 -0.071144 0.038521 0.000536 0.054713 0.025494 0.075619 -2.282991 4.767552 -0.063400 0.070802 -0.097049 0.038527 0.156864 0.054433 0.028806 0.075874	0.002051 0.016135 0.127 -0.021634 0.038986 -0.555 0.033627 0.055594 0.605 -0.076404 0.071034 -1.076 -2.431470 4.768416 -0.510 -0.062196 0.068599 -0.907 -0.071144 0.038521 -1.847 0.000536 0.054713 0.010 0.025494 0.075619 0.337 -2.282991 4.767552 -0.479 -0.063400 0.070802 -0.895 -0.097049 0.038527 -2.519 0.156864 0.054433 2.882 0.028806 0.075874 0.380

L3.lnD_ChC	-0.029317	0.070941	-0.413	0.679
L4.lnD_St	-0.102680	0.038816	-2.645	0.008
L4.lnD_Li	0.124486	0.054770	2.273	0.023
L4.lnD_InR	0.020750	0.071531	0.290	0.772
L4.lnD_TwF	1.324049	0.759590	1.743	0.081
L4.lnD_ChC	-0.000605	0.068695	-0.009	0.993

Results for equation lnD_Li

	coefficient	std. error	t-stat	prob
const	0.004222	0.011302	0.374	0.709
L1.lnD St	0.063431	0.027307	2.323	0.020
L1.lnD Li	-0.095980	0.038939	-2.465	0.014
L1.lnD InR	-0.035930	0.049754	-0.722	0.470
L1.lnD TwF	4.445284	3.339924	1.331	0.183
L1.lnD ChC	0.007010	0.048048	0.146	0.884
L2.lnD St	-0.011243	0.026981	-0.417	0.677
L2.lnD Li	-0.237696	0.038323	-6.203	0.000
L2.lnD InR	-0.001470	0.052966	-0.028	0.978
L2.lnD TwF	0.210201	3.339319	0.063	0.950
L2.lnD ChC	-0.025883	0.049591	-0.522	0.602
L3.lnD St	0.049976	0.026985	1.852	0.064
L3.lnD Li	-0.160515	0.038126	-4.210	0.000
L3.lnD InR	0.039736	0.053144	0.748	0.455
L3.lnD_TwF	6.372247	3.352807	1.901	0.057
L3.lnD_ChC	-0.005298	0.049689	-0.107	0.915
L4.lnD_St	-0.056511	0.027187	-2.079	0.038
L4.lnD_Li	-0.085151	0.038362	-2.220	0.026
L4.lnD_InR	0.019321	0.050102	0.386	0.700
L4.lnD_TwF	-1.246112	0.532037	-2.342	0.019
L4.lnD_ChC	0.019821	0.048116	0.412	0.680
=========	==============		===========	

Results for equation lnD_InR

	coefficient	std. error	t-stat	prob
const	-0.021078	0.008936	-2.359	0.018
L1.lnD St	0.002079	0.021590	0.096	0.923
L1.lnD Li	0.012384	0.030787	0.402	0.688
L1.lnD InR	0.391736	0.039337	9.959	0.000
L1.lnD TwF	4.124323	2.640649	1.562	0.118
L1.lnD ChC	0.011133	0.037989	0.293	0.769
L2.lnD St	0.029743	0.021332	1.394	0.163
L2.lnD Li	0.024203	0.030299	0.799	0.424
L2.lnD InR	0.312194	0.041876	7.455	0.000
L2.lnD TwF	6.465456	2.640170	2.449	0.014
L2.1nD ChC	-0.035852	0.039208	-0.914	0.361
L3.lnD St	0.036965	0.021336	1.733	0.083
L3.lnD Li	-0.045246	0.030144	-1.501	0.133
L3.lnD InR	0.039676	0.042018	0.944	0.345
L3.lnD TwF	-4.969857	2.650834	-1.875	0.061
L3.1nD ChC	0.021752	0.039285	0.554	0.580
L4.lnD St	-0.030140	0.021495	-1.402	0.161
L4.lnD Li	-0.022427	0.030330	-0.739	0.460
L4.lnD InR	0.060898	0.039612	1.537	0.124
L4.lnD TwF	-0.007620	0.420645	-0.018	0.986
L4.lnD_ChC	0.012100	0.038042	0.318	0.750

Results for equation lnD_TwF

coefficient	std. error	t-stat	prob

const	0.000648	0.000133	4.879	0.000
L1.lnD_St	0.000327	0.000321	1.019	0.308
L1.lnD_Li	0.000188	0.000457	0.411	0.681
L1.lnD_InR	-0.000940	0.000584	-1.608	0.108
L1.lnD_TwF	0.034510	0.039225	0.880	0.379
L1.lnD_ChC	-0.000940	0.000564	-1.666	0.096
L2.lnD_St	0.000531	0.000317	1.675	0.094
L2.lnD_Li	0.000550	0.000450	1.222	0.222
L2.lnD_InR	0.000112	0.000622	0.180	0.857
L2.lnD_TwF	0.071151	0.039218	1.814	0.070
L2.lnD_ChC	-0.000407	0.000582	-0.699	0.485
L3.lnD_St	0.000063	0.000317	0.198	0.843
L3.lnD_Li	0.000241	0.000448	0.538	0.591
L3.lnD_InR	0.000421	0.000624	0.674	0.500
L3.lnD_TwF	0.025598	0.039377	0.650	0.516
L3.lnD_ChC	0.000447	0.000584	0.766	0.443
L4.lnD_St	0.000791	0.000319	2.476	0.013
L4.lnD_Li	0.000636	0.000451	1.411	0.158
L4.lnD_InR	0.000187	0.000588	0.317	0.751
L4.lnD_TwF	-0.001250	0.006248	-0.200	0.841
L4.lnD_ChC	0.000318	0.000565	0.562	0.574

Results for equation lnD ChC

==========				
	coefficient	std. error	t-stat	prob
const	0.000164	0.009256	0.018	0.986
	0.010791	0.022363	0.483	0.629
L1.lnD_St				
L1.lnD_Li	0.012737	0.031890	0.399	0.690
L1.lnD_InR	-0.037581	0.040747	-0.922	0.356
L1.lnD TwF	-0.187661	2.735283	-0.069	0.945
L1.lnD_ChC	-0.293580	0.039350	-7.461	0.000
L2.lnD_St	0.003143	0.022097	0.142	0.887
L2.lnD_Li	-0.018107	0.031385	-0.577	0.564
L2.lnD_InR	-0.048345	0.043377	-1.115	0.265
L2.lnD_TwF	-0.599224	2.734787	-0.219	0.827
L2.lnD_ChC	-0.158314	0.040614	-3.898	0.000
L3.lnD_St	0.005585	0.022100	0.253	0.800
L3.lnD_Li	-0.027331	0.031224	-0.875	0.381
L3.lnD_InR	0.042748	0.043523	0.982	0.326
L3.lnD_TwF	-0.820204	2.745833	-0.299	0.765
L3.lnD_ChC	-0.140270	0.040693	-3.447	0.001
L4.lnD_St	0.007748	0.022266	0.348	0.728
L4.lnD_Li	-0.007229	0.031417	-0.230	0.818
L4.lnD_InR	0.070688	0.041032	1.723	0.085
L4.lnD_TwF	-0.365614	0.435720	-0.839	0.401
L4.lnD_ChC	0.005402	0.039405	0.137	0.891

Correlation matrix of residuals

```
        lnD_St
        lnD_Li
        lnD_InR
        lnD_TwF
        lnD_ChC

        lnD_St
        1.000000
        0.036389
        -0.004696
        0.005619
        -0.018338

        lnD_Li
        0.036389
        1.000000
        -0.090208
        -0.042498
        0.013945

        lnD_InR
        -0.004696
        -0.090208
        1.000000
        0.032745
        -0.024368

        lnD_TwF
        0.005619
        -0.042498
        0.032745
        1.000000
        -0.010256

        lnD_ChC
        -0.018338
        0.013945
        -0.024368
        -0.010256
        1.000000
```

```
# We can use the forecast function to produce this forecast.
          # Note that we have to specify the "initial value" for the forecast:
          lag orderSC = resultsSC.k ar
          forecastSC = resultsSC.forecast(resultsSCs.params.to numpy(), 12)
          print(f'forecastSC:\n{forecastSC}\n')
          print('Forecasts: Apple Music')
          print(' lnD St lnD Li lnD InR lnD TwF
                                                                     lnD ChC ')
          print(np.sum(forecastSC, axis=0))
         forecastSC:
         [-7.54672396e-01 -3.27320840e-01 -2.06287623e-01 -1.20922980e-04
           -4.17505785e-01]
          [-3.08800679e-01 -7.84717797e-01 -2.71585706e-01 -1.87481260e-03
            1.16755876e-01]
          [-1.02621849e+00 -6.39170906e-01 -3.47205451e-01 -9.18267165e-04]
            2.88623770e-021
          \begin{bmatrix} -2.21379288e-01 & 7.21920284e-01 & -2.39305769e-01 & -9.96774191e-04 \end{bmatrix}
            3.70085144e-01]
           [ 1.52945297e+00 2.47229332e-01 -3.55003218e-01 -7.42571813e-04
            6.70551913e-021
          [-1.69717797e-01 1.28541412e-01 -1.96724469e-01 1.89400937e-03
            1.16466953e-01]
          [ 2.31984689e-01 2.43695998e-01 -6.11218370e-02 5.93951133e-04
           -7.36269176e-02]
           [ 1.12232510e-01 4.12621197e-02 -1.11042989e-01 6.45108459e-04
            2.17671230e-031
          [-1.29738890e-01 -1.12146717e-01 -9.45624232e-02 2.34379281e-03]
           -1.24483918e-01]
          [-4.92382884e-02 2.76962951e-01 6.55530049e-02 4.56552537e-03
            7.27371515e-02]
          [ 8.06386215e-02 3.64611475e-02 -9.04549034e-02 -6.81936039e-04
            5.05650760e-021
           [-1.72611945e-01 -2.30276661e-01 -6.10074582e-02 1.41158219e-03
            5.03278519e-02]]
         Forecasts: Apple Music
            lnD St lnD Li lnD InR lnD TwF
                                                            lnD ChC
         [-0.87806898 -0.39755968 -1.96874884 0.00611868 0.25941571]
In [102...
          # The forecast interval function will produce the above forecast along with asymptotic sta
          # These can be visualized using the plot forecast function:
          resultsSCs.plot forecast(12)
          # Impulse Response Analysis
          # Impulse responses are of interest in econometric studies:
          # they are the estimated responses to a unit impulse in one of the variables.
          # They are computed in practice using the MA(\infty) representation of the VAR(p) process:
          # Yt = \mu + \sum_{i=0}^{\infty} to \infty \Phi_i ut^{-i}
          # We can perform an impulse response analysis by calling the irf function on a VARResults
          # These can be visualized using the plot function, in either orthogonalized or non-orthogo
          # Asymptotic standard errors are plotted by default at the 95% significance level, which
          irf = resultsSCs.irf(12)
          irf.plot(orth=False)
          # The cumulative effects \Psi n = \sum ni = 0\Phi i can be plotted with the long run effects as follows:
          irf.plot cum effects(orth=False)
          # Granger causality
          # One is often interested in whether a variable or group of variables is "causal" for ano
          # for some definition of "causal". In the context of VAR models,
          # one can say that a set of variables are Granger-causal within one of the VAR equations.
```

```
# See Wooldridge p. 626 for a discussion of Granger causality.
# The VARResults object has the test causality method
# for performing either a Wald (\chi2) test or an F-test.
print('Test for Granger causality for Streams\n')
print(resultsSCs.test causality('lnD St', ['lnD Li', 'lnD InR', 'lnD TwF', 'lnD ChC'], kind=
print('Test for Granger causality for IGReach\n')
print(resultsSCs.test causality('lnD InR', ['lnD St', 'lnD Li', 'lnD TwF', 'lnD ChC'], kind=
# Normality
# The white noise component ut is assumed to be normally distributed.
# While this assumption is not required for parameter estimates to be consistent or asymp
# results are generally more reliable in finite samples when residuals are Gaussian white
# To test whether this assumption is consistent with a data set, VARResults offers the test
# Note: Stock market return data are frequently NOT normally distributed!
print(resultsSCs.test normality())
```

Test for Granger causality for Streams

Test for Granger causality for IGReach

<statsmodels.tsa.vector_ar.hypothesis_test_results.NormalityTestResults object. H_0: data
generated by normally-distributed process: reject at 5% significance level. Test statisti
c: 46582.520, critical value: 18.307>, p-value: 0.000>

300

400

500

600

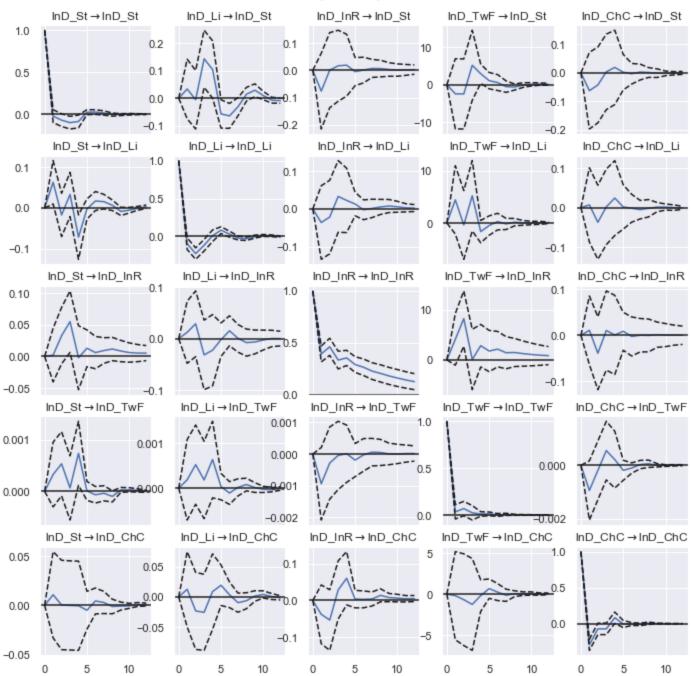
700

0

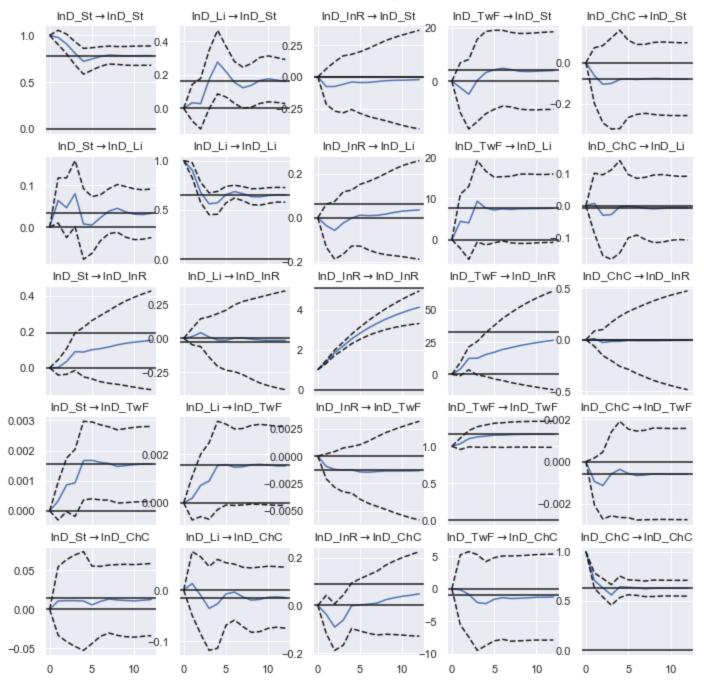
100

200

Impulse responses



Cumulative responses



Spotify, VAR Estimation:

```
In [98]:
```

- # make a VAR model
- # Vector Autoregression Model
- # VAR(p) processes
- # See Wooldridge p. 626 for a discussion of VAR models.
- # It should be noted that much financial timeseries data are non-stationary.
- # Before any analysis it is a good idea to plot the data, test for unit roots, and probabl
- # construct the log-differences in the data to obtain % return that are almost always stat
- # In the code above, I have constructed the log-differenced data for the etf funds.
- # We are interested in modeling a T×K
- # multivariate time series Y, where T denotes the number of observations
- # and K the number of variables. One way of estimating relationships
- # between the time series and their lagged values is the vector autoregression process:
- # $Yt = v + A1 \ Yt-1 + ... + Ap \ Yt-p + ut where ut~Normal(0,\Sigma u)$ and A is a K×K coefficient material $t = v + A1 \ Yt-1 + ... + Ap \ Yt-p + ut$
- # see https://www.statsmodels.org/dev/vector ar.html

```
var modelSP = VAR(lnSP)
resultsSP = var modelSP.fit()
print(f'resultsSP.summary():\n{resultsSP.summary()}\n')
resultsSP.plot()
resultsSP.plot acorr()
/opt/anaconda3/lib/python3.8/site-packages/statsmodels/tsa/base/tsa model.py:590: ValueWar
ning: An unsupported index was provided and will be ignored when e.g. forecasting.
 warnings.warn('An unsupported index was provided and will be'
resultsSP.summary():
 Summary of Regression Results
```

Model: Method: OLS Date: Wed, 09, Feb, 2022 14:58:46

No. of Equations: 5.00000 BIC: -23.9988 Nobs: 666.000 HQIC: -24.1230 3364.05 FPE: Log likelihood: 3.08608e-11

-24.2015 Det(Omega_mle): 2.95075e-11

Results for equation lnD St

AIC:

______ std. error coefficient t-stat ______ 0.788 0.008922 0.011316 -6.895 0.000 5.743 0.000 0.192 0.847 -2.891 0.612 ______

Results for equation lnD Li

=========				
	coefficient	std. error	t-stat	prob
const	0.007618	0.010802	0.705	0.481
L1.lnD_St	-0.082253	0.063067	-1.304	0.192
L1.lnD Li	0.013424	0.067709	0.198	0.843
L1.lnD InR	0.005799	0.044653	0.130	0.897
L1.lnD TwF	-0.607308	0.647656	-0.938	0.348
L1.lnD_ChC	0.017583	0.048235	0.365	0.715
=========				

Results for equation lnD InR

	.==========			========
	coefficient	std. error	t-stat	prob
const	-0.026452	0.008194	-3.228	0.001
L1.lnD St	-0.031325	0.047841	-0.655	0.513
L1.lnD_Li	0.053371	0.051362	1.039	0.299
L1.lnD_InR	0.497939	0.033873	14.700	0.000
L1.lnD TwF	-1.034490	0.491297	-2.106	0.035
L1.lnD_ChC	0.027309	0.036590	0.746	0.455
=========				

Results for equation lnD TwF

	coefficient	std. error	t-stat	prob
const	0.000759	0.000120	6.314	0.000
L1.lnD_St	0.001103	0.000702	1.572	

L1.lnD_Li	-0.000782	0.000753	-1.038	0.299
L1.lnD_InR	-0.000465	0.000497	-0.935	0.350
L1.lnD_TwF	0.002416	0.007207	0.335	0.737
L1.lnD_ChC	-0.000865	0.000537	-1.612	0.107

Results for equation lnD_ChC

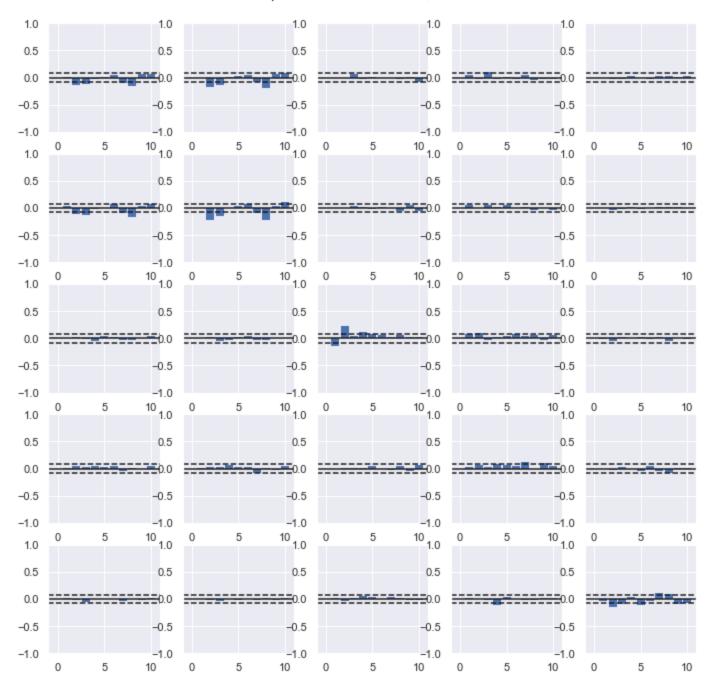
=========				
	coefficient	std. error	t-stat	prob
const	-0.002316	0.008443	-0.274	0.784
L1.lnD St	-0.065227	0.049293	-1.323	0.186
L1.lnD Li	0.080340	0.052921	1.518	0.129
L1.lnD InR	-0.012589	0.034901	-0.361	0.718
L1.lnD TwF	-0.943002	0.506209	-1.863	0.062
L1.lnD_ChC	-0.241039	0.037701	-6.393	0.000

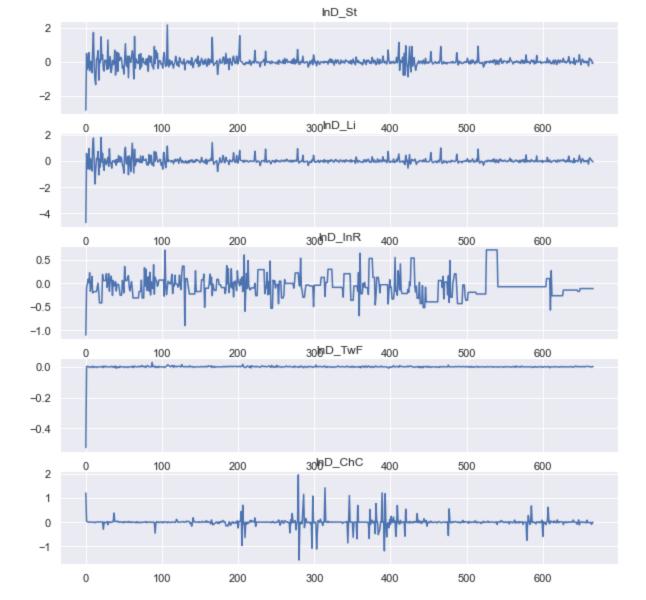
Correlation matrix of residuals

	lnD_St	lnD_Li	lnD_InR	lnD_TwF	lnD_ChC
lnD_St	1.000000	0.841388	-0.026631	-0.012648	0.026501
lnD_Li	0.841388	1.000000	-0.063575	-0.054145	0.033218
lnD_InR	-0.026631	-0.063575	1.000000	0.050737	-0.014276
lnD_TwF	-0.012648	-0.054145	0.050737	1.000000	-0.003551
lnD_ChC	0.026501	0.033218	-0.014276	-0.003551	1.000000

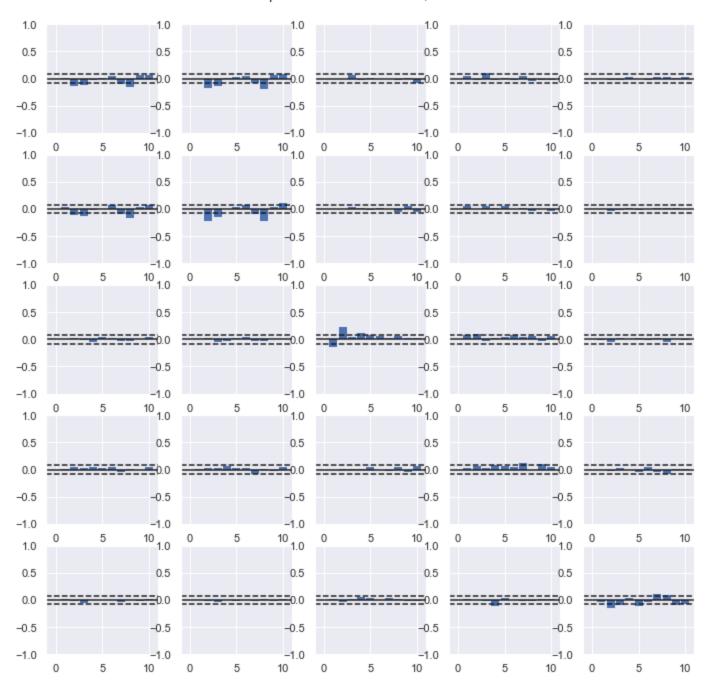
Out[98]:

ACF plots for residuals with $2/\sqrt{T}$ bounds



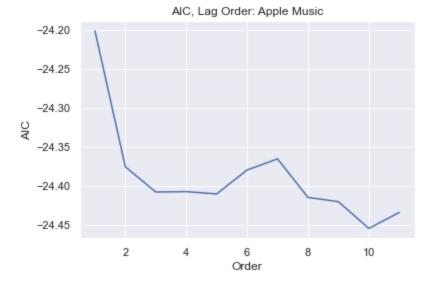


ACF plots for residuals with 2/√T bounds



```
In [99]:
    resultsSP_aic = []
    for p in range(1,12):
        resultsSP = var_modelSP.fit(p)
        resultsSP_aic.append(resultsSP.aic)

    import seaborn as sns
    sns.set()
    plt.title('AIC, Lag Order: Apple Music')
    plt.plot(list(np.arange(1,12,1)), resultsSP_aic)
    plt.xlabel("Order")
    plt.ylabel("AIC")
    plt.show()
```



Lowest AIC appears to occur @ (Order10, AIC-24.45)

```
In [105...
# Lag order selection
# Choice of lag order can be a difficult problem.
# Standard analysis employs likelihood test or information criteria-based order selection.
# We have implemented the latter, accessible through the VAR class:

# When calling the fit function, one can pass a maximum number of lags
# and the order criterion to use for order selection:
var_modelSP.select_order(10)
resultsSPs = var_modelSP.fit(maxlags=10, ic='aic')
print(f'resultsSPs.summary():\n{resultsSPs.summary()}\n')
```

resultsSPs.summary():

Summary of Regression Results

Model: VAR
Method: OLS
Date: Wed, 09, Feb, 2022
Time: 15:02:13

No. of Equations: 5.00000 BIC: -23.8661
Nobs: 664.000 HQIC: -24.1981
Log likelihood: 3472.61 FPE: 2.51028e-11
AIC: -24.4081 Det(Omega_mle): 2.22853e-11

Results for equation lnD St

______ coefficient std. error t-stat ______ const 0.011676 0.011863 0.984 0.325 0.011863 0.072287 0.077479 0.055536 3.605078 0.051314 0.078530 0.081674 0.056145 3.610026 0.052905 0.072746 0.078402 0.055336 L1.lnD St -0.423947 -5.865 0.000 L1.lnD Li 0.339963 4.388 0.000 L1.lnD InR -0.013109 -0.236 0.813 L1.lnD TwF 2.573978 0.714 0.475 0.023728 0.038807 L1.lnD ChC 0.462 0.644 0.494 L2.lnD St 0.621 -0.226892 L2.lnD Li -2.778 0.005 L2.lnD InR -0.005501 -0.098 0.922 L2.lnD TwF -3.228012 -0.894 0.371 L2.lnD ChC -0.019940 -0.377 0.706 0.049092 0.675 L3.1nD St 0.500 L3.lnD Li -0.204685 -2.611 0.009 L3.lnD InR 0.055336 0.058303 1.054 0.292 0.691945 1.908020 2.757 L3.lnD TwF 0.006 L3.lnD_ChC -0.035157 0.051410 -0.684 0.494

Results for equation lnD Li

==========	=======================================		=======================================	
	coefficient	std. error	t-stat	prob
const	0.008217	0.011026	0.745	0.456
L1.lnD_St	0.058966	0.067187	0.878	0.380
L1.lnD_Li	-0.152594	0.072012	-2.119	0.034
L1.lnD_InR	-0.009618	0.051618	-0.186	0.852
L1.lnD_TwF	3.876442	3.350703	1.157	0.247
L1.lnD_ChC	0.018354	0.047693	0.385	0.700
L2.lnD_St	0.303226	0.072989	4.154	0.000
L2.lnD_Li	-0.497028	0.075911	-6.547	0.000
L2.lnD_InR	-0.018968	0.052183	-0.363	0.716
L2.lnD_TwF	-1.439495	3.355302	-0.429	0.668
L2.lnD_ChC	-0.026303	0.049172	-0.535	0.593
L3.lnD_St	0.093426	0.067613	1.382	0.167
L3.lnD_Li	-0.254724	0.072870	-3.496	0.000
L3.lnD_InR	0.051937	0.051432	1.010	0.313
L3.lnD_TwF	2.747385	0.643121	4.272	0.000
L3.lnD_ChC	-0.019810	0.047783	-0.415	0.678

Results for equation lnD_InR

=========	=======================================			
	coefficient	std. error	t-stat	prob
const	-0.027718	0.008342	-3.323	0.001
L1.lnD St	-0.031191	0.050831	-0.614	0.539
L1.lnD Li	0.042049	0.054482	0.772	0.440
L1.lnD InR	0.325681	0.039052	8.340	0.000
L1.lnD TwF	4.721625	2.535014	1.863	0.063
L1.lnD ChC	0.009938	0.036083	0.275	0.783
L2.1nD St	-0.027133	0.055220	-0.491	0.623
L2.lnD Li	0.064099	0.057432	1.116	0.264
L2.lnD InR	0.294279	0.039480	7.454	0.000
L2.lnD TwF	6.636291	2.538493	2.614	0.009
L2.1nD ChC	-0.037402	0.037202	-1.005	0.315
L3.1nD St	0.048530	0.051154	0.949	0.343
L3.lnD Li	-0.071701	0.055130	-1.301	0.193
L3.1nD InR	0.044204	0.038911	1.136	0.256
L3.lnD TwF	-0.015995	0.486561	-0.033	0.974
L3.lnD_ChC	0.006762	0.036151	0.187	0.852

Results for equation lnD TwF

Nebateb for equation ins_inf					
	coefficient	std. error	t-stat	prob	
const	0.000677	0.000129	5.243	0.000	
L1.lnD St	0.001572	0.000787	1.997	0.046	
L1.lnD Li	-0.001232	0.000844	-1.460	0.144	
L1.lnD InR	-0.000867	0.000605	-1.433	0.152	
L1.lnD TwF	0.034905	0.039268	0.889	0.374	
L1.lnD ChC	-0.000999	0.000559	-1.787	0.074	
L2.lnD St	0.001094	0.000855	1.279	0.201	
L2.lnD Li	-0.000577	0.000890	-0.649	0.516	
L2.lnD InR	0.000303	0.000612	0.496	0.620	
L2.lnD TwF	0.075368	0.039322	1.917	0.055	
L2.lnD ChC	-0.000483	0.000576	-0.839	0.402	
L3.lnD St	0.000947	0.000792	1.195	0.232	
L3.lnD Li	-0.000682	0.000854	-0.798	0.425	
L3.lnD_InR	0.000410	0.000603	0.680	0.496	
L3.lnD TwF	0.003453	0.007537	0.458	0.647	

L3.1nD_ChC 0.000357 0.000560 0.638 0.523

Results for equation lnD ChC

=========				
	coefficient	std. error	t-stat	prob
const	-0.001704	0.008957	-0.190	0.849
L1.lnD_St	-0.058779	0.054582	-1.077	0.282
L1.lnD Li	0.073861	0.058502	1.263	0.207
L1.lnD InR	-0.032735	0.041934	-0.781	0.435
L1.lnD TwF	-0.016577	2.722073	-0.006	0.995
L1.lnD ChC	-0.285966	0.038745	-7.381	0.000
L2.lnD St	0.020302	0.059295	0.342	0.732
L2.lnD Li	-0.032683	0.061669	-0.530	0.596
L2.lnD InR	-0.035921	0.042393	-0.847	0.397
L2.lnD_TwF	-0.595346	2.725808	-0.218	0.827
L2.lnD ChC	-0.159228	0.039947	-3.986	0.000
L3.1nD St	-0.052770	0.054928	-0.961	0.337
L3.lnD Li	0.024438	0.059199	0.413	0.680
L3.lnD_InR	0.073007	0.041783	1.747	0.081
L3.lnD TwF	-0.508729	0.522464	-0.974	0.330
L3.lnD_ChC	-0.141584	0.038818	-3.647	0.000

Correlation matrix of residuals

print(np.sum(forecastSP, axis=0))

```
lnD_St lnD_Li lnD_InR lnD_TwF lnD_ChC lnD_St 1.000000 0.839414 -0.035683 -0.004933 0.010160 lnD_Li 0.839414 1.000000 -0.072996 -0.057067 0.014727 lnD_InR -0.035683 -0.072996 1.000000 0.028458 -0.020049 lnD_TwF -0.004933 -0.057067 0.028458 1.000000 -0.004966 lnD_ChC 0.010160 0.014727 -0.020049 -0.004966 1.000000
```

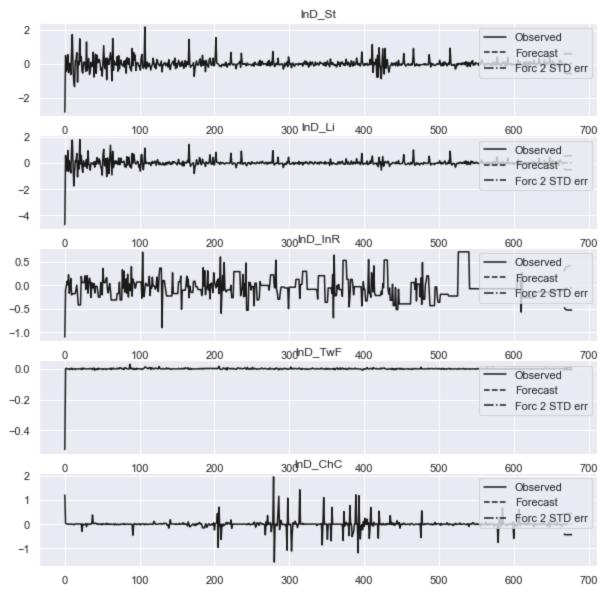
```
 [-2.74801299e-01 \ -3.72593491e-01 \ -1.45777060e-01 \ 1.65183224e-03 ] \\
 -9.87312231e-021
 [-3.28261081e-02 4.67928905e-02 -1.09121191e-01 -6.73138559e-05
 -7.42529535e-021
 [ 1.62393939e-01 3.19538589e-01 -1.24746178e-01 1.45624484e-03
  1.82449385e-01]
 9.95076406e-031
[-6.41755321e-02 -1.04780695e-01 5.00868322e-02 4.20137760e-03
[ 2.98272360e-02 -2.37990162e-02 -6.45440337e-02 -1.11023405e-03
 -7.91119640e-02]]
Forecasts: Spotify
  lnD St lnD Li lnD InR lnD TwF lnD ChC
[-0.98773468 -1.36943813 0.25107666 0.01996231 0.64445024]
# The forecast interval function will produce the above forecast along with asymptotic sta
# These can be visualized using the plot forecast function:
resultsSPs.plot forecast(12)
# Impulse Response Analysis
# Impulse responses are of interest in econometric studies:
# they are the estimated responses to a unit impulse in one of the variables.
# They are computed in practice using the MA(\infty) representation of the VAR(p) process:
# Yt = \mu + \sum_{i=0}^{n} to \infty \Phi_i ut^{-i}
# We can perform an impulse response analysis by calling the irf function on a VARResults
# These can be visualized using the plot function, in either orthogonalized or non-orthogo
# Asymptotic standard errors are plotted by default at the 95% significance level, which
irf = resultsSPs.irf(12)
irf.plot(orth=False)
# The cumulative effects \Psi n = \sum ni = 0\Phi i can be plotted with the long run effects as follows:
irf.plot cum effects(orth=False)
# Granger causality
# One is often interested in whether a variable or group of variables is "causal" for ano
# for some definition of "causal". In the context of VAR models,
# one can say that a set of variables are Granger-causal within one of the VAR equations.
# See Wooldridge p. 626 for a discussion of Granger causality.
# The VARResults object has the test causality method
# for performing either a Wald (\chi 2) test or an F-test.
print('Test for Granger causality for Streams\n')
print(resultsSPs.test causality('lnD St', ['lnD Li', 'lnD InR', 'lnD TwF', 'lnD ChC'], kind=
print('Test for Granger causality for IGReach\n')
print(resultsSPs.test causality('lnD InR', ['lnD St', 'lnD Li', 'lnD TwF', 'lnD ChC'], kind=
# Normality
# The white noise component ut is assumed to be normally distributed.
# While this assumption is not required for parameter estimates to be consistent or asympt
# results are generally more reliable in finite samples when residuals are Gaussian white
# To test whether this assumption is consistent with a data set, VARResults offers the test
# Note: Stock market return data are frequently NOT normally distributed!
print(resultsSPs.test normality())
Test for Granger causality for Streams
```

In [108...

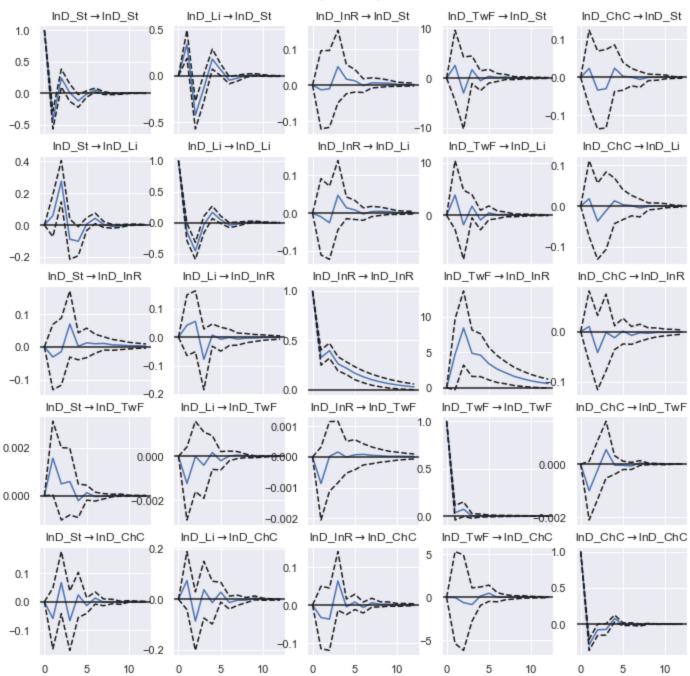
<statsmodels.tsa.vector ar.hypothesis test results.CausalityTestResults object. H 0: ['lnD</pre>

Test for Granger causality for IGReach

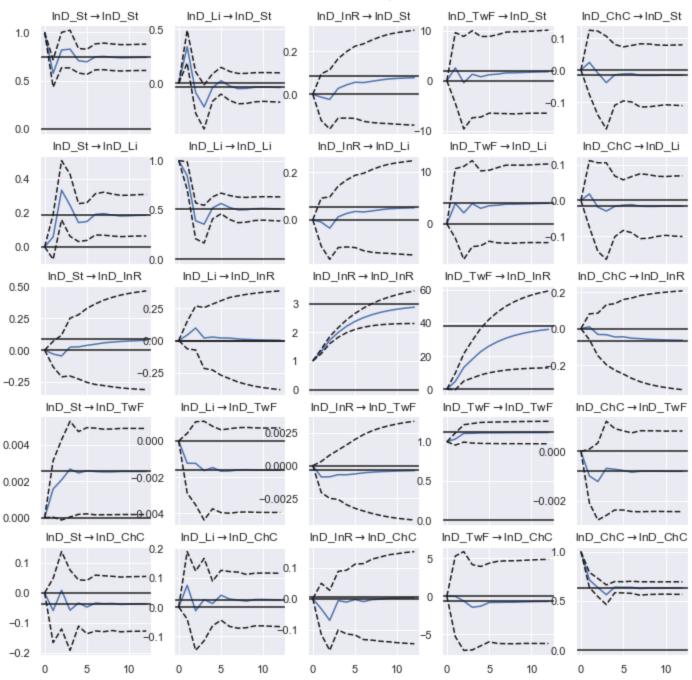
<statsmodels.tsa.vector_ar.hypothesis_test_results.NormalityTestResults object. H_0: data
generated by normally-distributed process: reject at 5% significance level. Test statisti
c: 26673.109, critical value: 18.307>, p-value: 0.000>



Impulse responses



Cumulative responses



In []: