Machine Learning for Finance: Assignment Two

Due on Tuesday, May 31, 2018

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Contents

1 Problem 1

1.1 Default Yield Spread & SP500 Equity Premium- Causality Analysis

In the following analysis we shall implement a Granger Test to examine the potential for a causal relationship between the Default Yield Spread and S&P500 Equity Premium.

Influence of Default Yield Spread on S&P500 Equity Premium

Table 1: Influence of Default Yield Spread on S&P500 Equity Premium at lags 1 to 9

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9
1927/1932	0.22	0.05	0.03						
1933/1970	0.08	0.03	0.07	0.13	0.03	0.01	0.00	0.00	0.00
1971/1997	0.08								
1998/2005	0.16								

N.B. blank cells represent non-optimal lags

This analysis exhibits significant correlations in in the periods from 1927 to 1932 and from 1933 to 1970. This indicating that the Default Yield Spread's (DFY) previous realisations had a statistically significant potentially causal correlation with the returns of S&P500 Equity Premium during these periods.

From 1927 until 1932 the only significant finding at the 5% level comes at the third lag and from 1933 until 1970 statiscially significant levels are found at lags 2 and then from 5 to 9.

Influence of S&P500 Equity Premium on Default Yield Spread

Table 2: Influence of S&P500 Equity Premium on Default Yield Spread at lags 1 to 9

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9
1927/1932	0.04	0.00	0.00						
1933/1970	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1971/1997	0.00								
1998/2005	0.56								

N.B. blank cells represent non-optimal lags

This analysis exhibits significant correlations in in the periods from 1927 to 1932, from 1933 to 1970, and from 1971 until 1997. This indicating that the S&P500 Equity Premium's previous realisations had a statistically significant potentially causal correlation with the returns of DFY during these periods.

From 1927 until 1932 the only significant finding at the 5% level comes at the second and third lags, from 1933 until 1970 statiscially significant levels are found from lag 2 to 9, and finally for the period 1971 to 1997 the first lag is found to be significant.

In conclusion although significant lags using the Granger Test have been demonstrated in both analyses both series have been shown to exhibit significant lags during the same periods indicating that rather than representing **true** causality this represents a contemporanous realtionship between the variables.

1.2 Book-to-Market Ratio & SP500 Equity Premium- Causality Analysis

Influence of Book-to-Market Ratio on S&P500 Equity Premium

Table 3: Influence of Book-to-Market Ratio on S&P500 Equity Premium at lags 1 to 9

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9
1927/1932	0.11	0.20	0.24						
1933/1970	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00
1971/1997	0.00								
1998/2005	0.87								

N.B. blank cells represent non-optimal lags

This analysis exhibits significant correlations in in the periods from 1933 to 1970 and 1971 to 1997. This indicates that the Book-to-Market Ratio's (BM) previous realisations had a statistically significant potentially causal correlation with the returns of S&P500 Equity Premium during these periods.

From 1933 until 1970 findings are significant at the 5% level for all lags and from 1971 until 1997 statistically significant levels are found at the first lag.

Influence of S&P500 Equity Premium on Book-to-Market Ratio

Table 4: Influence of S&P500 Equity Premium on Book-to-Market Ratio at lags 1 to 9

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9
1927/1932	0.20	0.02	0.19						
1933/1970	0.00	0.00	0.00	0.05	0.01	0.02	0.04	0.07	0.00
1971/1997	0.00								
1998/2005	0.25								

N.B. blank cells represent non-optimal lags

This analysis exhibits significant correlations in in the periods from 1927 to 1932, from 1933 to 1970, and from 1971 until 1997. This indicating that the S&P500 Equity Premium's previous realisations had a statistically significant potentially causal correlation with the returns of the BM during these periods.

From 1927 until 1932 the only significant finding at the 5% level comes at the second lag, from 1933 until 1970 statiscially significant levels are found from lag 1 to 7 then also for lag 9, and finally for the period 1971 to 1997 the first lag is found to be significant.

In conclusion although significant lags using the Granger Test have been demonstrated in both analyses both series have been shown to exhibit significant lags during the same periods indicating that rather than representing **true** causality this represents a contemporanous realtionship between the variables.

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2 Problem 2

In the following section we shall examine causal correlations of returns between eleven major global equity indices at lags of between one and four periods.

2.1 Major World Indices Returns - Causality Analysis

	BSESN	BVSP	FTSE	GDAXI	GSPC	HSCE	IBEX	JKSE	MXX	N225	TWII
BSESN		0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1
BVSP	1, 1, 1, 1		1, 1, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1
FTSE	1, 1, 1, 1	0, 0, 0, 0		1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1
GDAXI	1, 1, 1, 1	0, 0, 0, 0	0, 0, 1, 1		0, 1, 1, 1	1, 1, 1, 1	0, 0, 1, 0	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1
GSPC	1, 1, 1, 1	1, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1		1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1
HSCE	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0		0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1
IBEX	1, 1, 1, 1	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	1, 1, 1, 1		1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1
JKSE	0, 0, 0, 0	1, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0		0, 0, 0, 0	0, 0, 0, 1	0, 0, 0, 0
MXX	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1		1, 1, 1, 1	1, 1, 1, 1
N225	1, 1, 1, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0		0, 0, 0, 0
TWII	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 0, 0	0, 0, 1, 1	0, 0, 0, 0	0, 0, 0, 0	

This analysis exhibits significant one-way causal relationships in the between the indices listed across all lags. The fact that it is one-way suggests that the relationships is not merely a contemporaneous relationship but rather a **true** causal relationship. While these relationships are statistically significant we hypothesize that these relationships are due to time zone differences, a quirk in the data, rather than actual causality of returns. The economic reasoning behind this that there are common macroeconomic factors that influence all stock exchanges such as commodity prices, news releases, and investor sentiment. As the data-set includes close prices, these are staggered due to time-zones and henceforth create an artificial delay in for some indices.

BSESN

- HSCE
- JKSE
- TWII

BVSP

- BSESN
- HSCE
- IBEX
- N225
- TWII

FTSE

- BSESN
- GDAXI
- HSCE
- IBEX
- JKSE
- N225
- TWII

GDAXI

- BSESN
- JKSE
- N225
- TWII

GSPC

- BSESN
- FTSE
- HSCE
- IBEX
- JKSE
- N225
- TWII

HSCE

- N225
- TWII

IBEX

- IBEX
- HSCE
- JKSE
- N225
- TWII

MXX

- BSESN
- FTSE
- GDAXI
- HSCE
- IBEX
- JKSE
- N225
- TWII

2.2 Major World Indices Volatility - Causality Analysis

In the following section we shall examine causal volatility correlations between eleven major global equity indices at lags of between one and four periods. To calculate voltility we took the sum of squared returns.

	BSESN	BVSP	FTSE	GDAXI	GSP	HSCE	IBEX	JKSE	MXX	N225	TWII
BSEN		0, 1, 1, 0	1, 1, 1, 1	0, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	0, 0, 1, 1	1, 1, 1, 1	0, 1, 1, 1	1, 1, 1, 1	1, 1, 1, 1
BVSP	0, 1, 1, 1		0, 1, 1, 1	0, 1, 1, 1	0, 1, 0, 0	1, 1, 1, 1	0, 1, 1, 1	0, 1, 0, 0	0, 0, 0, 0	0, 1, 1, 1	1, 1, 1, 1
FTSE	1, 1, 1, 1	0, 1, 1, 1		1, 1, 0, 0	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1	0, 1, 1, 1	1, 1, 1, 1	0, 1, 1, 1	1, 1, 1, 0
GDAXI	1, 1, 1, 1	0, 1, 1, 1	0, 0, 0, 0		0, 0, 0, 0	1, 1, 1, 1	0, 0, 1, 1	0, 1, 1, 1	0, 0, 1, 1	0, 1, 1, 1	1, 1, 1, 1
GSP	0, 0, 0, 0	1, 1, 1, 1	0, 1, 1, 1	0, 1, 1, 1		1, 1, 1, 1	0, 1, 1, 1	0, 1, 1, 1	0, 0, 0, 0	0, 1, 1, 1	0, 1, 1, 0
HSCE	0, 1, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 0, 1, 0	0, 0, 0, 0		1, 1, 0, 0	0, 1, 0, 0	0, 0, 1, 0	0, 0, 0, 0	1, 1, 1, 1
IBEX	0, 1, 1, 1	0, 1, 0, 1	1, 1, 0, 0	0, 0, 0, 0	0, 0, 0, 0	1, 1, 1, 1		0, 1, 1, 1	0, 0, 0, 0	0, 1, 1, 1	1, 1, 1, 1
JKSE	1, 1, 1, 1	0, 0, 0, 1	0, 0, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1		1, 1, 1, 0	1, 1, 1, 0	1, 1, 1, 1
MXX	1, 1, 1, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	0, 0, 0, 1	1, 1, 1, 1	1, 1, 1, 0	0, 1, 1, 1		0, 1, 1, 1	1, 1, 1, 1
N225	1, 1, 1, 1	0, 1, 1, 1	0, 0, 0, 0	0, 1, 0, 0	0, 0, 0, 1	1, 1, 1, 1	1, 1, 0, 0	0, 0, 1, 1	0, 1, 1, 1		1, 1, 1, 0
TWII	1, 0, 0, 0	1, 1, 1, 1	1, 0, 0, 1	1, 1, 1, 1	0, 0, 0, 0	1, 1, 1, 1	1, 1, 1, 1	1, 0, 0, 0	0, 1, 1, 0	1, 0, 0, 1	

The volatility analysis exhibits less causal relationships than that for returns however there are multiple potentially causal relationships demonstrated. That said, the results demonstrate the same pattern of following time zones as the analysis of returns. This detracts from the significance of the results.

Problem 2 continued on next page...

2.3 Major World Indices Returns - Clustering Analysis

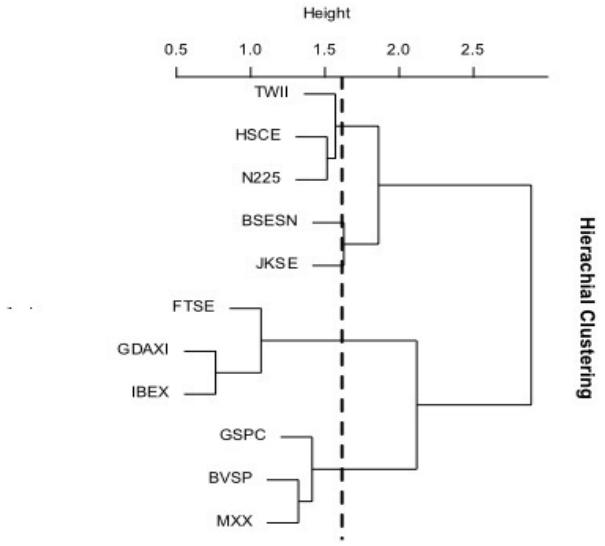
The diagram on the following page and table below exhibit a clustering analysis of the eleven previously examined stock indices across six different time periods. We based the distance measure on Kendall Correlation and using hierarchical clustering with The Ward Metric.

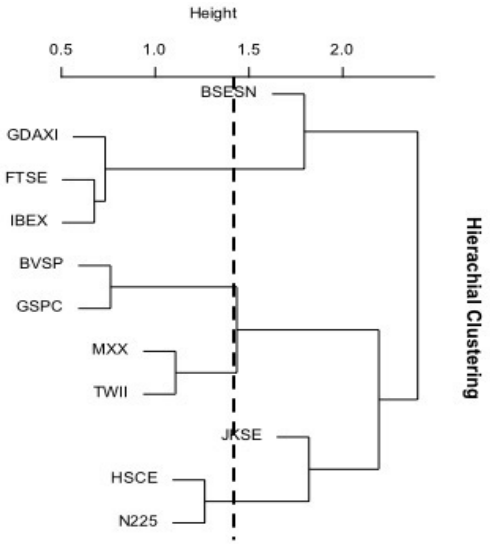
Table 5: Clustering Groups of Eleven Major Indices Across Six Periods From 2004 until 2006

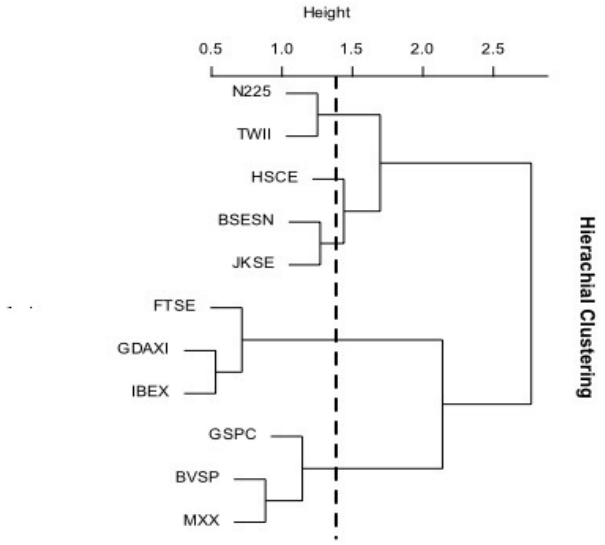
	BSESN	BVSP	FTSE	GDAXI	GSPC	HSCE	IBEX	JKSE	MXX	N225	TWII
2004-01/2004-06	1	2	3	3	2	4	3	5	6	4	6
2004-07/2004-12	1	2	3	3	2	1	3	4	2	5	5
2005-01/2005-06	1	2	3	3	2	4	3	5	2	4	4
2005-07/2005-12	1	2	3	3	2	4	3	5	2	4	4
2006-01/2006-06	1	2	3	3	2	4	3	1	2	5	5
2006-07/2006-12	1	2	3	3	2	4	3	4	2	5	5

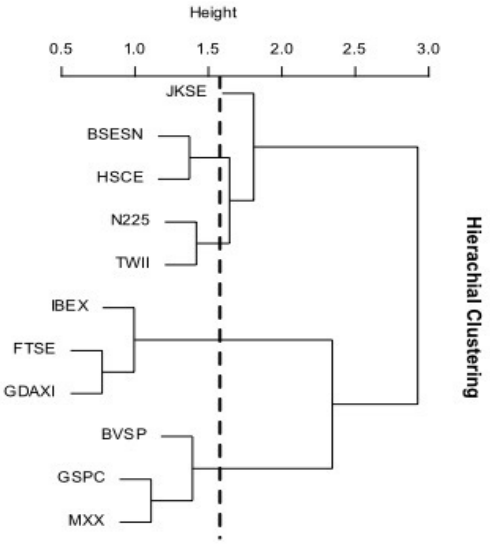
As demonstrated in Table 5 we can see some indices consistently are clustered together over time suggesting lasting relationships whereas other indices expereince greater fluctuations regarding their Kendall Correlations with other indices. For example, the FTSE, GDAXI, and IBEX are grouped together across all periods meanwhile the JKSE, N225, and TWII migrate to different clusters much more frequently.

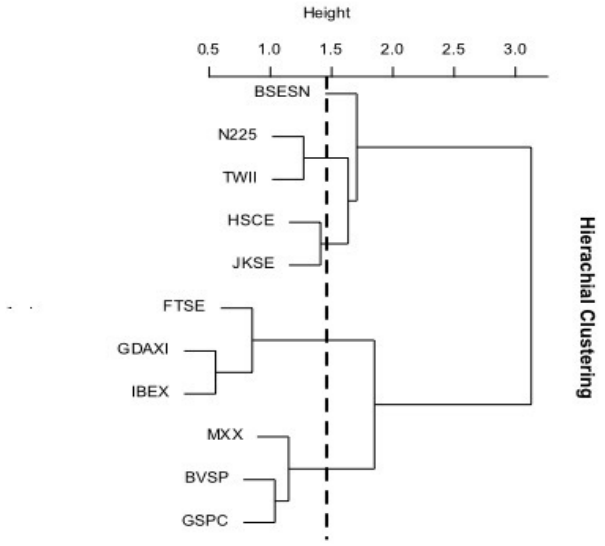
Problem 2 continued on next page...

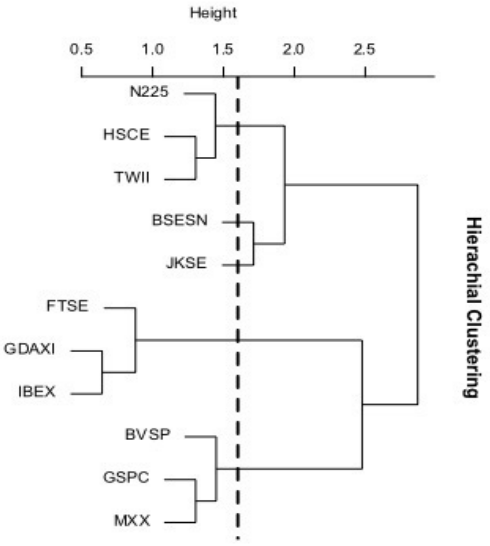












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