Market states: A new understanding

Hirdesh K. Pharasi[1,*], **Eduard Seligman**[2], **and Thomas H. Seligman**[1,3]

[1]Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, Cuernavaca-62210, México
[2]Swiss Air Trainer S.A. Payerne, Vaud, Switzerland
[3]Centro Internacional de Ciencias, Cuernavaca-62210, México
[*]hirdeshpharasi@gmail.com

ABSTRACT

We present the clustering analysis of the financial markets of S&P 500 (USA) and Nikkei 225 (JPN) markets over a period of 2006-2019 as an example of a complex system. We investigate the statistical properties of correlation matrices constructed from the sliding epochs. The correlation matrices can be classified into different clusters, named as "market states" based on the similarity of correlation structures. We cluster the S&P 500 market into four and Nikkei 225 into six market states by optimizing the value of intracluster distances. The market shows transitions between these market states and the statistical properties of the transitions to critical market states can indicate likely precursors to the catastrophic events. We also analyze the same clustering technique on surrogate data constructed from average correlations of market states and the fluctuations arise due to the white noise of short time series. We use the correlated Wishart orthogonal ensemble for the construction of surrogate data whose average correlation equals the average of the real data.

Introduction

Some time ago a proposal to consider correlation matrices to define market states was put forward and found some resonance[1]. A noise suppression technique was applied directly to the correlation matrices[2] and thereafter a clustering tree was established and eight market states were established with a certain degree of arbitrariness. Since then ideas from this paper have resonated inside and outside our group. Alternative techniques to handle non-stationary time series through spectral properties have been developed in[3–5]. Other approaches to behave at critical or catastrophic moments have been put forward by various authors[6–10]. More recently two of us participated in a proposal[11] to improve the choice of cluster by simultaneously optimizing the clustering process and the noise suppression parameter. We expanded the analysis from the original study of S&P 500 market by including the Nikkei 225 market. The results were essentially a dynamics consistent with the master equation and transitions to the highest correlation cluster mainly from the previous one, which thus allowed to determine possible precursors. The study had the disadvantage of counting to a large extent old data of last century. We here propose to refine the methods further and to improve the criteria to reduce the number of precursors in a given time period and also to get a better understanding of the transition dynamics between states. We also address a basic weakness of the previous studies that implied roughly that the average correlation or equivalently the largest eigenvalues of the correlation matrix, largely determine to which cluster a given correlation matrix belongs. In the Japanese market we found an interesting essential non-linear evolution, as well as a smaller basis of precursor states, thus reducing the risk base. Also we develop a technique of surrogate data based on correlated orthogonal Wishart ensembles (CWOE) draping white noise around the average correlation of each state. This gives a strong indication as to the interrelation of correlation and noise that we see.

In the present work we shall make actual connection to this matrix by noise to the correlation matrices pertaining to the market states by forming a correlated Wishart ensemble[12–14] from the average correlation matrix representing each market state. We shall find that the clusters obtained for each market state are reasonably related to the original clusters if we chose the same time frame for the added noise. We extend the analysis to the Japanese market to confirm our findings as far as the validity of the clustering is concerned and we finally present the result, that a highly turbulent market-phase started near the Lehman Brother crash and terminated around 2016. The latter result is more clear for the US market than for the Japanese market. This likely results from two facts: The data basis (number of stocks) is smaller for the Japanese market and the Japanese market has six states. Both properties make more noise. On the other hand the fact that two intermediate states of the Japanese market display practically the same average correlation eliminates the disturbing fact mentions in[1] that the average correlation actually dominates the definition of market states to large extent. We thus give a solid base to the concept of market states, as we show, how the clusters, i.e., the market states are made up from average correlations and noise.

Methodology and results

We begin with the identification of market states as a clusters of similar correlation matrices. We have used the adjusted daily closure prices of the stocks making up the two indices S&P 500 of US market (USA) and Nikkei 225 of Japanese market (JPN). We have considered $N = 350$ stocks of the S&P 500 index and $N = 156$ stocks of the Nikkei 225 index traded in the 14-year period from January 2006 to December 2019 which correspond to $T = 3523$ and $T = 3459$ trading days, respectively. Here we include only those stocks which were present for the entire duration of 14 years. We have also shown in the supplementary material of $N = 368$ stocks of the S&P 500 index and $N = 173$ stocks of the Nikkei 225 index for 13-year period from January 2006 to December 2018 which correspond to $T = 3270$ and $T = 3219$ trading days, respectively. The list of the stock considered for the analysis are also listed in the supplementary material. We construct a Pearson cross-correlation matrix (equal-time) of the returns $r_i(\tau)$ of stock i: $C_{ij}(\tau) = (\langle r_i r_j \rangle - \langle r_i \rangle \langle r_j \rangle)/\sigma_i \sigma_j$, where the epoch average $\langle \dots \rangle$ and the standard deviations σ are computed over that epoch of size 20 days with $i, j = 1, ..., N$ and τ is the end date of the epoch using daily returns. Note that we do not compensate for weekends or holidays! However, the short time series the correlation matrices become highly singular[15, 16]. We use the power map method[2, 11, 12, 17], for noise-suppression. In this method, a nonlinear distortion is given to each cross-correlation coefficient within an epoch by: $C_{ij} = sign(C_{ij})|C_{ij}|^{1+\varepsilon}$, where $\varepsilon \in (0, 1)$ is the noise-suppression parameter. We then study the evolution of the cross-correlation structures $C(\tau)$ of returns for epochs of 20 days with 10-day overlap.

(a)

(b)
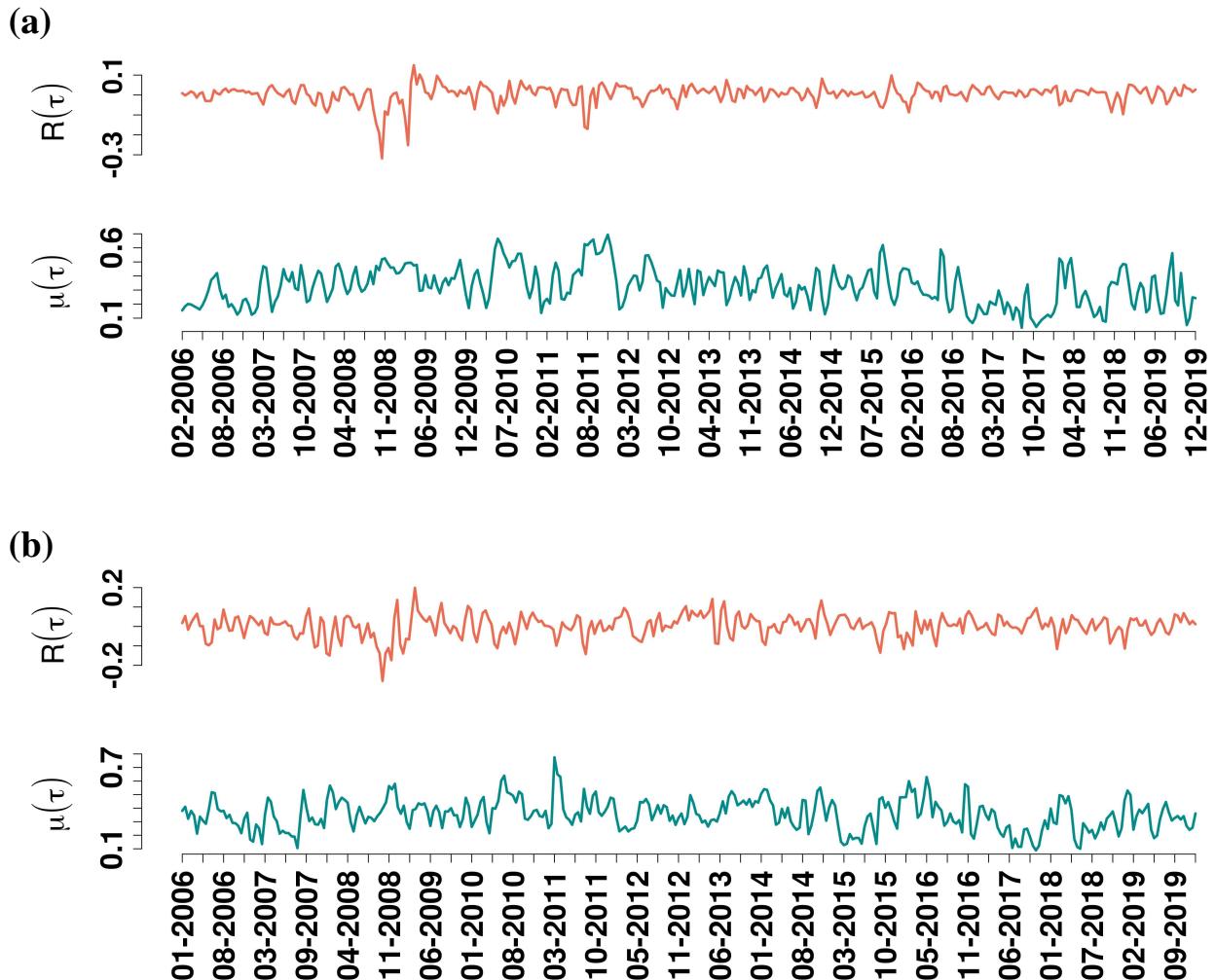
Figure 1. Temporal evolution of (**a**) S&P 500 and (**b**) Nikkei 225 markets over a period of 2006-2019. The returns of the two market indices $R(\tau)$ as well as the corresponding average correlations of the stock returns $\mu(\tau)$ are shown in the plots.
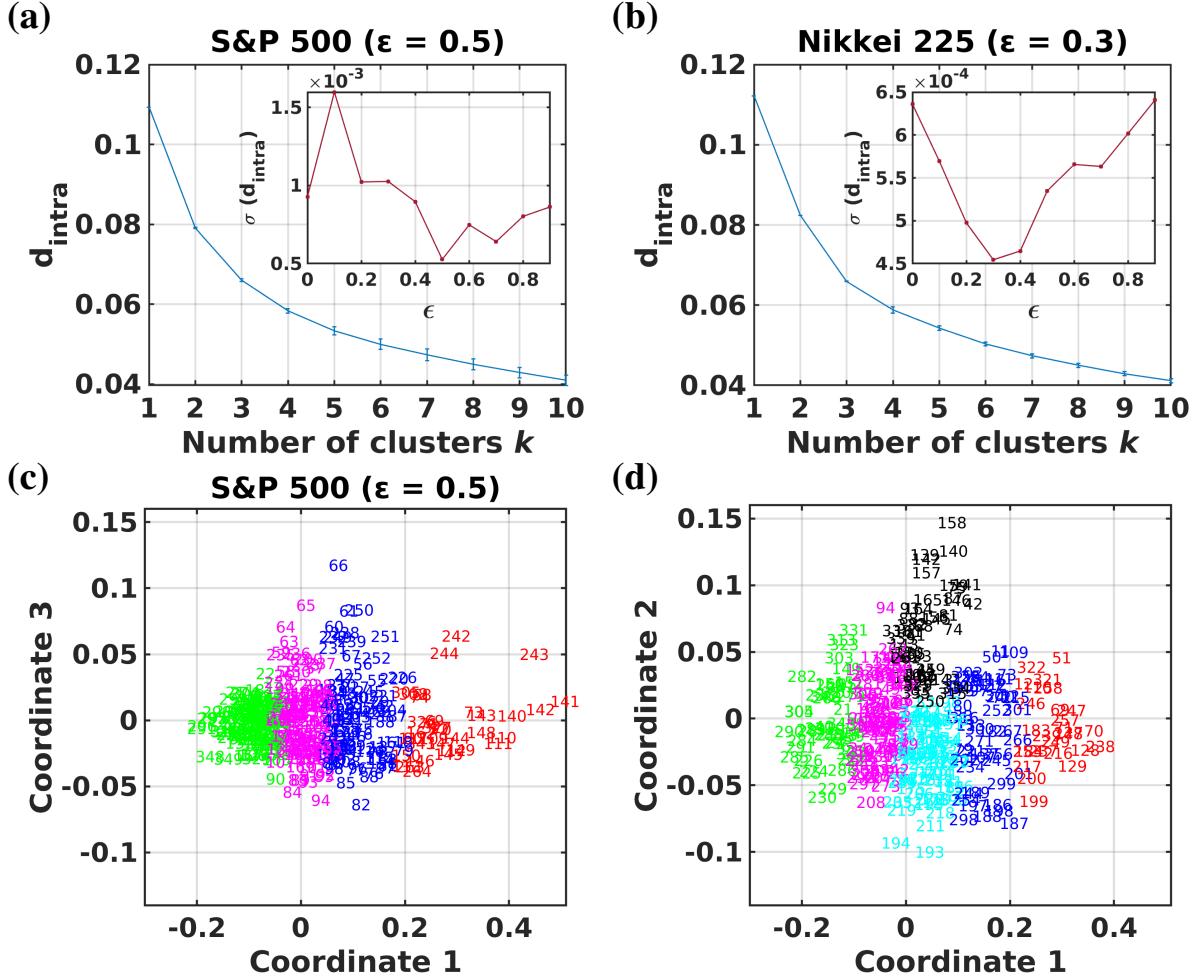
Figure 2. Classification of market states based on optimal intra cluster distances for S&P 500 and Nikkei 225. The measure of the intra cluster distance d_{intra} calculated for different number of clusters is shown in (a) and (b) for S&P 500 and Nikkei 225, respectively. The three dimensional (3D) k-means clustering is performed on 351 noise-suppressed correlation frames of (c) S&P 500 and 344 noise-suppressed correlation frames of (d) Nikkei 225. Here, we use best 2D projection of 3D plots. The errorbar in the plot shows the deviations of the intra cluster distances calculated for 1000 different initial conditions. The plots show the minima of standard deviations at $k = 4$ for S&P 500 and $k = 6$ for Nikkei 225, respectively. Inset: Plots of d_{intra} measured for differnet noise-suppression parameters ε and shows minima at $\varepsilon = 0.5$ and $\varepsilon = 0.3$ for S&P 500 and Nikkei 225, respectively.

Figs. 1 (a) and (b) show the plots of the index returns $R(\tau)$ and mean market correlation $\mu(\tau)$ for S&P 500 and Nikkei 225, respectively. The rather different behavior of the two markets, which we will elaborate on later, already show in these simple measures.

We now define similarity measure for two correlation matrices $C(\tau_1)$ and $C(\tau_2)$ evaluated at different time τ_1 and τ_2 by the distance: $\zeta(C, C') \equiv \langle | C_{ij}(\tau_1) - C_{ij}(\tau_2) | \rangle_{ij}$, where $\langle ... \rangle_{ij}$ denotes the average over all components. The similarity matrices for S&P 500 and Nikkei 225 are shown in supplementary Figs. S2 and S3 for periods $2006 - 2019$ and $2006 - 2018$, respectively. The (dis-)similarity measure is thus a distance in a $N(N-1)/2$ dimensional space which is quite inconvenient particularly because the data set, i.e., the number of correlation matrices we have is smaller than the dimensionality. Multidimensional Scaling (MDS) is a method to accommodate the distances between a set of vectors in higher dimension to a lower dimensional space. This will not always be possible exactly. Thus a statistical method with random initial conditions and subsequent optimization is used as given in the code[18] to reproduce the distances as well as possible with a given tolerance. In our case we can do this by projection into a three dimensional (3D) space, which will allow visualization of projections or animated 3D

(a)

(b)
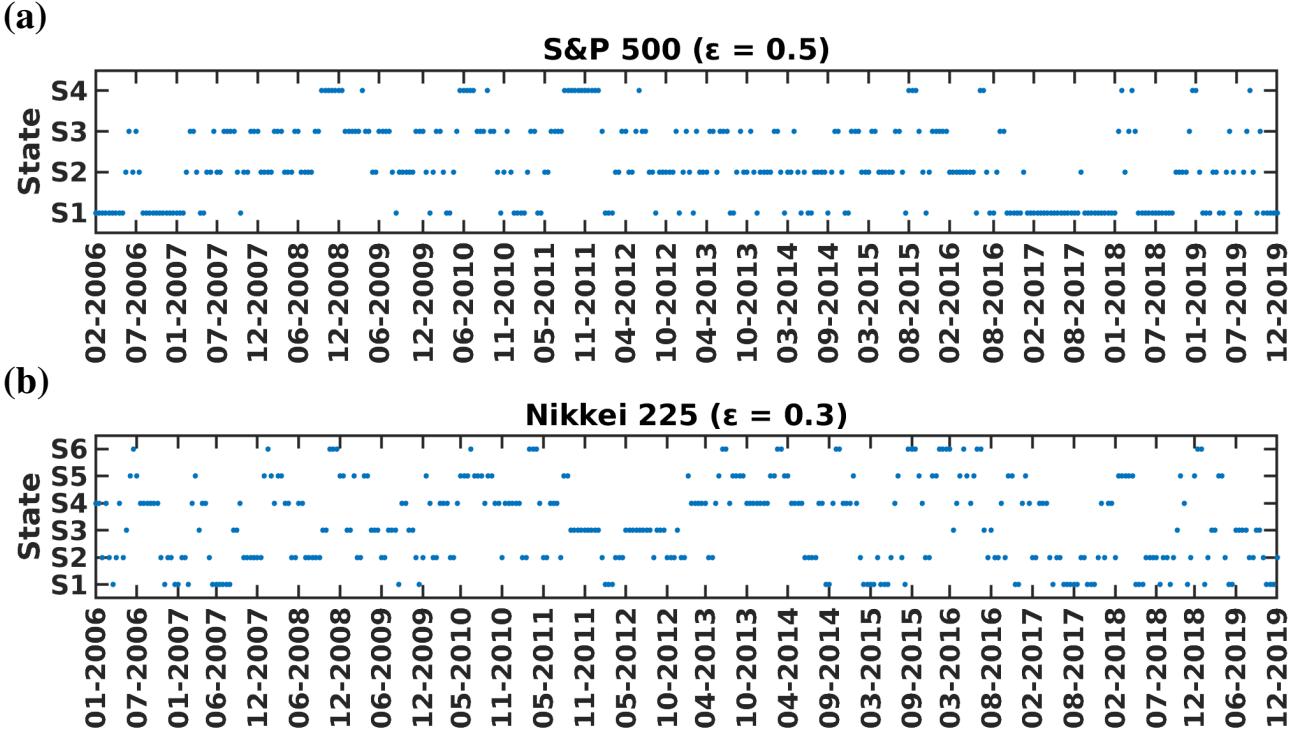
Figure 3. Plot shows dynamics of the S&P 500 and Nikkei 225 markets. (a) Evolution of S&P 500 market through the transitions between four different characterized states $S1, S2, S3$ and $S4$ over the period of $2006 - 2019$. (b) Evolution of Nikkei 225 market though the transitions between six different characterized states $S1, S2, S3, S4, S5$ and $S6$ for the period of $2006 - 2019$. US market, relative to Japanese market, is relative calm after 2016 and stays more in lower states.

arrangements. We use these suppressed data in a k-means procedure where we slightly improve the techniques of Ref.[11] to show the clustering of the recent data set. We use the noise suppressed correlation matrix as a starting point, and explicitly discard cluster numbers smaller than 4! As before we choose a noise-suppression, and a cluster number, which minimizes the variance of the intracluster distances generated by the random selections involved. The results are seen in Figs. 2 (a, c) for the US and Figs. 2 (b, d) for the Japanese market using $\varepsilon = 0.5$ and 0.3, respectively. The differences mentioned above concerning indices and average correlations now become much more striking. Compared to earlier data, the Japanese market shows one more cluster and while the clusters 3 and 4 are not entirely clear in the older data set. Now we have six clusters for a shorter time period and we encounter the phenomenon that the clusters by no means are in a quasi-linear arrangement which looks somewhat trivial, though it actually is not. Indeed we find that the alignment is along the average correlation, as already pointed out in the very first paper[1].

Figs. 3 (a) and (b) show the evolution of S&P 500 through the transitions among these four clusters named as market states $S1, S2, S3$, and $S4$ and Nikkei 225 through six market states $S1, S2, S3, S4, S5$ and $S6$ for the period of $2006 - 2019$, respectively. For the US market we find average correlations correspond to each market state $\mu(S1, S2, S3, S4) = (0.19, 0.31, 0.46, 0.63)$ are lined up according to the cluster index $S1, S2, S3, S4$, while we get for the Japanese market $\mu(S1, S2, S3, S4, S5, S6) = (0.21, 0.33, 0, 43, 0.44, 0.57, 0.68)$, where states $S3$ and $S4$ have practically the same average correlation. Note also that the transition probabilities of the Japanese market between states $S3$ and $S4$ are very small, and the absolute numbers ($S3 \to S4 = 3$, $S4 \to S3 = 1$) are not visible in the bar plot Fig. 4 (b). What properties of the two markets can reflect this nature should be open for discussion.

If the differences in variances of the intracluster measure d_{intra} are small, we suggest adding additional criteria relates to Fig. 4, where bar-plots for absolute transition numbers (see, Fig. 4 (a) and (b)) and probability graphs for the dynamics (see, Fig. 4 (c) and (d)) of both markets are shown. On one hand select a clustering that minimizes transitions between clusters, which is particularly apparent for the split pathways to high correlations seen above for the Japanese market. On the other hand a clustering that looks consistent with surrogate data, obtained as CWOE from the average correlation obtained for each cluster, as we shall discuss now. In the supplementary material we again show that the probabilities are consistent with a master equation as seen already in Ref.[11].

We can consider that the average correlation matrix obtained for each cluster to large extent characterizes the states. This
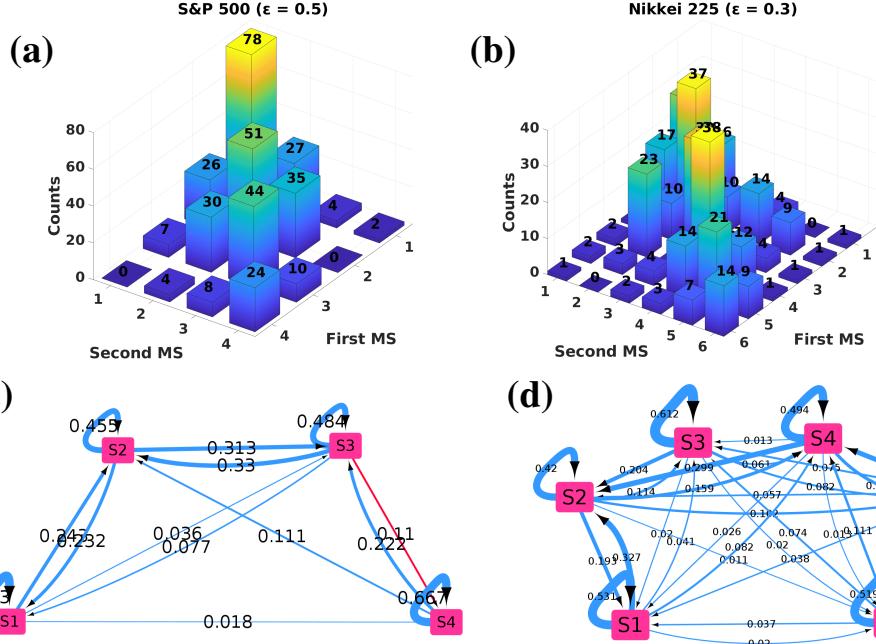
Figure 4. Bar plots show the transition counts (frequencies) of paired market states (MS) for (a) S&P 500 and (b) Nikkei 225 markets, respectively. The market show back and forth transitions between these states. Sometime the market remain in a particular state for a long time and sometime it jumps shortly to another state and jumps back or evolve further. Transitions to the nearby state are high probable. The networks plot of transition probabilities (see, Tables S1 and Tables S2) between different states of S&P 500 and Nikkei 225 are shown in (c) and (d) respectively. The probability of market state transition of $S3$ to $S4$ is 11% for S&P 500 market, and similarly, for Nikkei 225, the probability of market state transition of $S5$ to $S6$ is 17%.
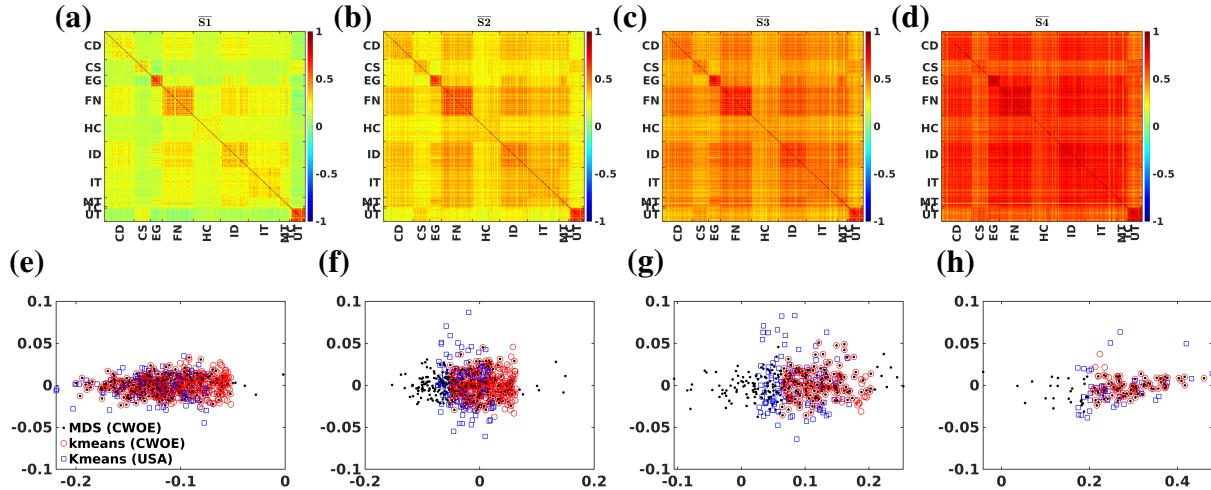
Figure 5. Plots of average correlation matrices of each market state of S&P 500 market and clustering analysis on surrogate data (CWOE). (a-d) The mean correlation matrices $\overline{Si}$ evaluated over all the correlation frames correspond to each market state $S1, S2, S3, \& S4$ but for the original correlation matrices ($\varepsilon = 0$). It shows the average behavior of each market states of S&P 500 over a period of 14 years (2006-2019). (e) Black dots (MDS (CWOE)) in plot show the MDS map of CWOE using mean correlations martix as $\overline{S1}$ and construction of three times bigger ensemble than $S1$ market state of S&P 500 market (see, Fig. 3 (a)) with the same noise-suppression $\varepsilon = 0.5$. Red circles (k-means (CWOE)) in plot show the points of the first cluster of k-means clustering performed on CWOE (dots). Blue squares (k-means (USA)) in the plot show the k-means clustering on the emperical data of S&P 500. k-means clustering on the CWOE and S&P 500 data shows a qualitative similar behavior. (f), (g), and (h) show the same for mean correlation matrices $\overline{S2}, \overline{S3}$, and $\overline{S4}$,, respectively.
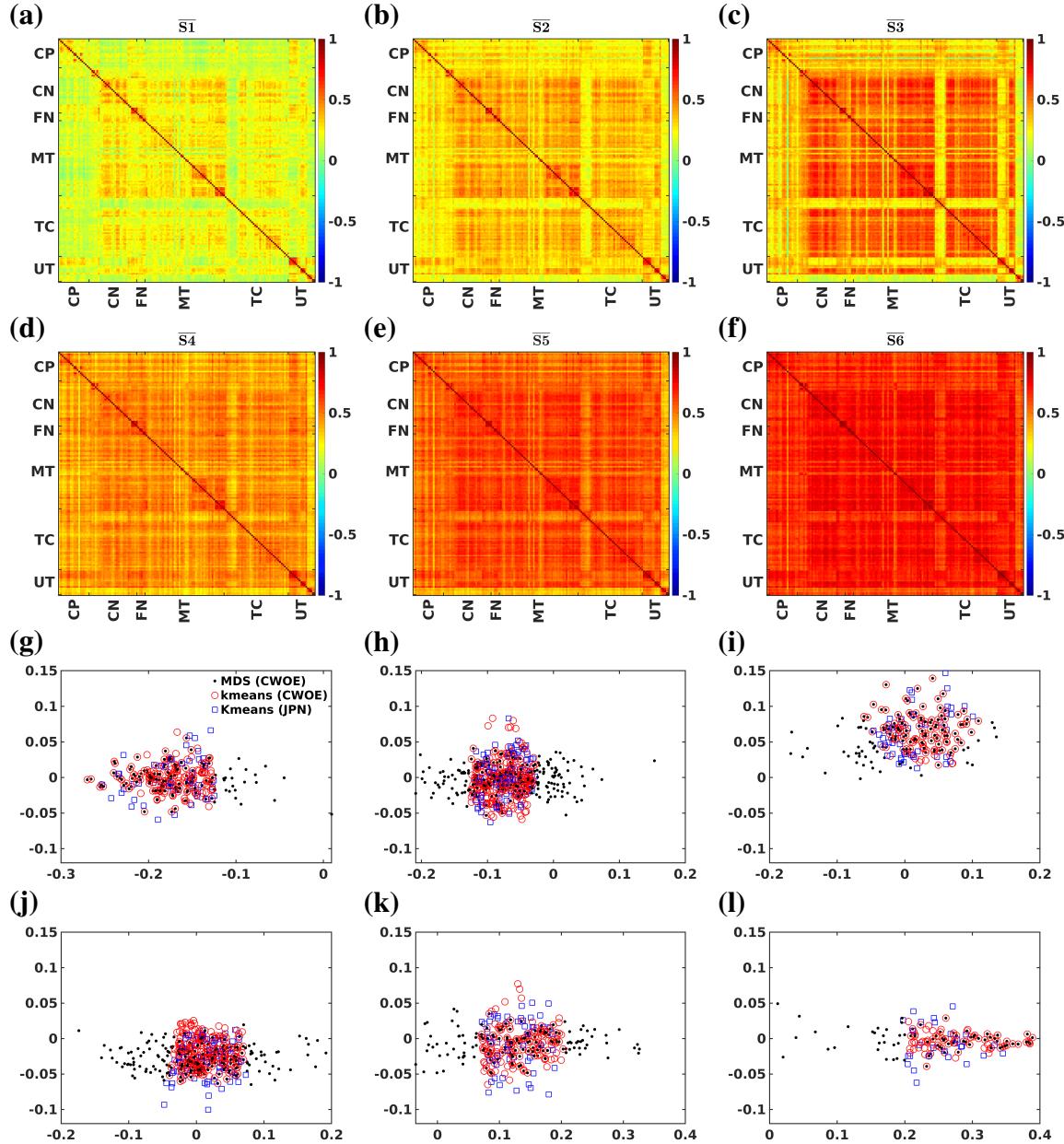
Figure 6. Plots of average correlation matrics of each market state of Nikkei 225 market and clustering analysis on surrogate data (CWOE). (a-f) The mean correlation $\overline{Si}$ evaluated over all the frames correspond to each market state $S1, S2, S3, \& S4$ but for original correlation frames ($\varepsilon = 0$). It shows the average behavior of all six market states of S&P 500 over a period of 14 years (2006-2019). (e) Black dots (MDS (CWOE)) in plot show the MDS map of CWOE using mean correlations martix as $\overline{S1}$ and construction of three times bigger ensemble than $S1$ market state of Nikkei 225 market (see, Fig. 3 (b)) with the same noise-suppression $\varepsilon = 0.3$. Red circles (k-means (CWOE)) in plot show the points of the first cluster of k-means clustering performed on CWOE (dots). Blue squares (k-means (USA)) in the plot show the k-means clustering on the emperical data of the Nikkei market. k-means clustering on the CWOE and S&P 500 data shows a qualitative similar behavior. (g), (h), (i), (j), (k), and (l) show the same for mean correlation matrices $\overline{S2}, \overline{S3}, \overline{S4}, \overline{S5}$, and $\overline{S6}$, respectively.

assumption implies that the cluster arises from noise around this average as given by a CWOE constructed from the average correlation matrix. Average correlation matrices of each market state of the S&P 500 market are shown in Fig. 5 (a-d). Fig. 5 (e), (f) (g), and (h) show the comparison of clustering analysis of surrogate data CWOE versus each state $S1, S2, S3$, and $S4$ of the S&P 500 market, respectively. k-means clustering (red circles) on the surrogate data (black dots) shows quantitatively similar behavior with the market states $S1, S2, S3, S4$ of S&P 500. Fig. 6 shows the same for six market states $S1, S2, S3, S4, S5$

and *S*6 of Japanese market. Clustering has a strong dependence on epoch size.

Discussions and Summary

We present improved criteria for the definition of clusters and thus market states and apply these to data sets starting in 2006 and ending in 2019 for both the US and the Japanese stock market as represented by the stocks in the S&P 500 and the Nikkei 225 indices. In general terms, we find that the turbulence that started in 2008 are awaiting to some extent. On the technical side we have improved the selection of precursors of market shocks and found a more detailed structure in the Japanese market that will allow a better understanding of market dynamics beyond the dominating influence of average correlation. This brings the idea of market states and their dynamics one step nearer to real market conditions and practical use. As shares are not the entire market at some point both derivative and bond prices as well as possible connections to intra-day trading will have to be included in such studies.

Acknowledgment

References

1. M. C. Münnix, T. Shimada, R. Schäfer, F. Leyvraz, T. H. Seligman, T. Guhr, and H. E. Stanley, Scientific Reports **2**, 644 (2012).

2. T. Guhr and B. Kälber, Journal of Physics A: Mathematical and General 36, 3009 (2003).

3. Vinayak, R. Schäfer, and T. H. Seligman, Physical Review E **88**, 032115 (2013).

4. T. Prosen, B. Buca, T. Seligman, *et al.*, EPL (Europhysics Letters) **108**, 20006 (2014).

5. D. Chetalova, R. Schäfer, and T. Guhr, Journal of Statistical Mechanics: Theory and Experiment 2015, P01029 (2015).

6. M. Gidea, D. Goldsmith, Y. Katz, P. Roldan, and Y. Shmalo, Physica A: Statistical Mechanics and its Applications, 123843 (2020).

7. T. Rings, M. Mazarei, A. Akhshi, C. Geier, M. R. R. Tabar, and K. Lehnertz, Scientific reports **9**, 1 (2019).

8. A. Mühlbacher and T. Guhr, Risks **6**, 42 (2018).

9. M. Vyas, T. Guhr, and T. Seligman, Scientific reports **8**, 1 (2018).

10. J. Jurczyk, T. Rehberg, A. Eckrot, and I. Morgenstern, Scientific reports **7**, 1 (2017).

11. H. K. Pharasi, K. Sharma, R. Chatterjee, A. Chakraborti, F. Leyvraz, and T. H. Seligman, New Journal of Physics **20**, 103041 (2018).

12. Vinayak and T. H. Seligman, in AIP Conference Proceedings, Vol. **1575** (AIP, 2014) pp. 196–217.

13. Vinayak and A. Pandey, Physical Review E **81**, 036202 (2010).

14. Z. Burda, J. Jurkiewicz, and B. Wac law, Phys. Rev. E **71**, 026111 (2005).

15. L. Laloux, P. Cizeau, J.-P. Bouchaud, and M. Potters, Phys. Rev. Lett. **83**, 1467 (1999).

16. V. Plerou, P. Gopikrishnan, B. Rosenow, L. A. Nunes Amaral, and H. E. Stanley, Phys. Rev. Lett. **83**, 1471 (1999).

17. H. K. Pharasi, K. Sharma, A. Chakraborti, and T. H. Seligman, "Complex market dynamics in the light of random matrix theory," in New Perspectives and Challenges in Econophysics and Sociophysics, edited by F. Abergel, B. K. Chakrabarti, A. Chakraborti, N. Deo, and K. Sharma (Springer International Publishing, Cham, 2019) pp. 13–34.

18. G. A. Seber, Multivariate observations, Vol. **252** (John Wiley & Sons, 2009).

SUPPLEMENTARY INFORMATION

Data considered for the analysis over a period of 2006-2019

Transition probabilities of the S&P 500 market between four states ($S1, S2, S3$, and $S4$) and Nikkei 225 between six states ($S1, S2, S3, S4, S5$, and $S6$) over the period of $2006 - 2019$ is given in Table S1 and Table S2, respectively. The data considered for the analysis are given in Table S3 and Table S4 for the same period.

Table S1. Transition probability of market states for
USA: Four market states (MS)

	S1	S2	S3	S4
S1	0.703	0.243	0.036	0.018
S2	0.232	0.455	0.313	0
S3	0.077	0.33	0.484	0.11
S4	0	0.111	0.222	0.667

Table S2. Transition probability of market states for JPN: Six market states (MS)

	S1	S2	S3	S4	S5	S6
S1	0.531	0.327	0.082	0.041	0.0	0.02
S2	0.193	0.42	0.159	0.114	0.102	0.011
S3	0.026	0.299	0.494	0.013	0.156	0.013
S4	0.02	0.204	0.061	0.612	0.082	0.02
S5	0.038	0.057	0.264	0.075	0.396	0.17
S6	0.037	0.0	0.111	0.074	0.259	0.519
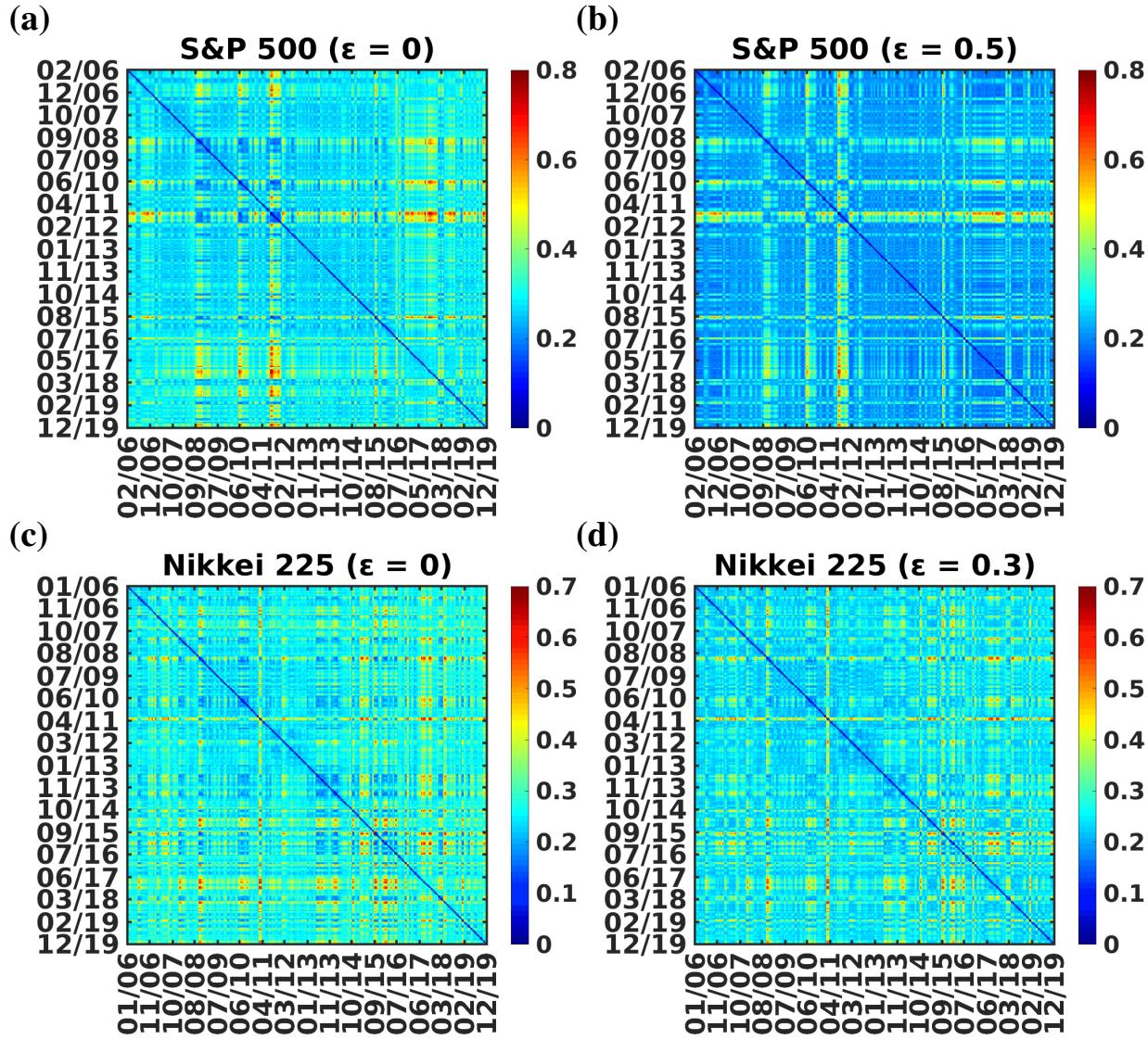
Figure S1. Similarity measure $\zeta(C,C')$ among 351 correlation matrices of S&P 500 (top row) and 344 correlation matrices of Nikkei 225 (bottom row). (a) and (c) are without noise-suppression $\varepsilon = 0$ and (b) and (d) are with noise-suppression $\varepsilon = 0.5$ and $\varepsilon = 0.3$, respectively. The evolution of the stock market over 14 years (2006–2019) can be understood from the similarity matrices. Critical events of the markets in red-yellow strips are shown in the similarity matrices. S&P 500 market is less volatile than Nikkei 225 and shows less fluctuations after 2012.

Data considered for the analysis over a period of 2006-2018

We show here similar results with data running up to 2018. The results for Japanese market differ substantially indicating a change in the general market situation. The data considered for the analysis are given in Table S5 and Table S6 for the period 2006-2018.
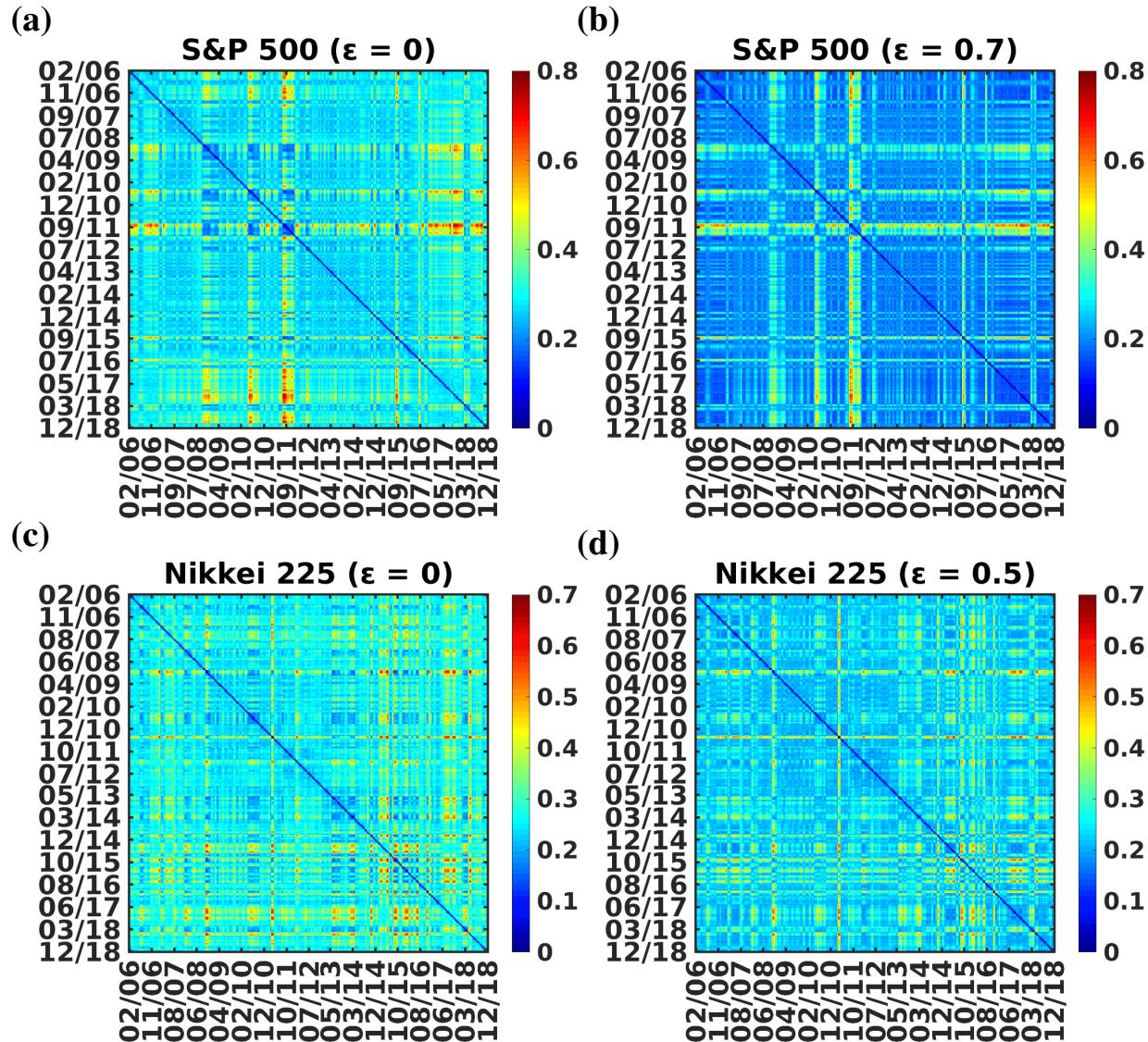
Figure S2. Plots of similarity measure $\zeta(C,C')$ of S&P 500 (top row) and Nikkei 225 (bottom row). Similarity measure among 325 correlation matrices of S&P 500 (top row) and 320 of Nikkei 225 (bottom row): (a) and (c) without noise-reduction $\varepsilon = 0$, and (b) and (d) with noise-reduction $\varepsilon = 0.7$ and $\varepsilon = 0.5$ over a period of 2006-2018, respectively.
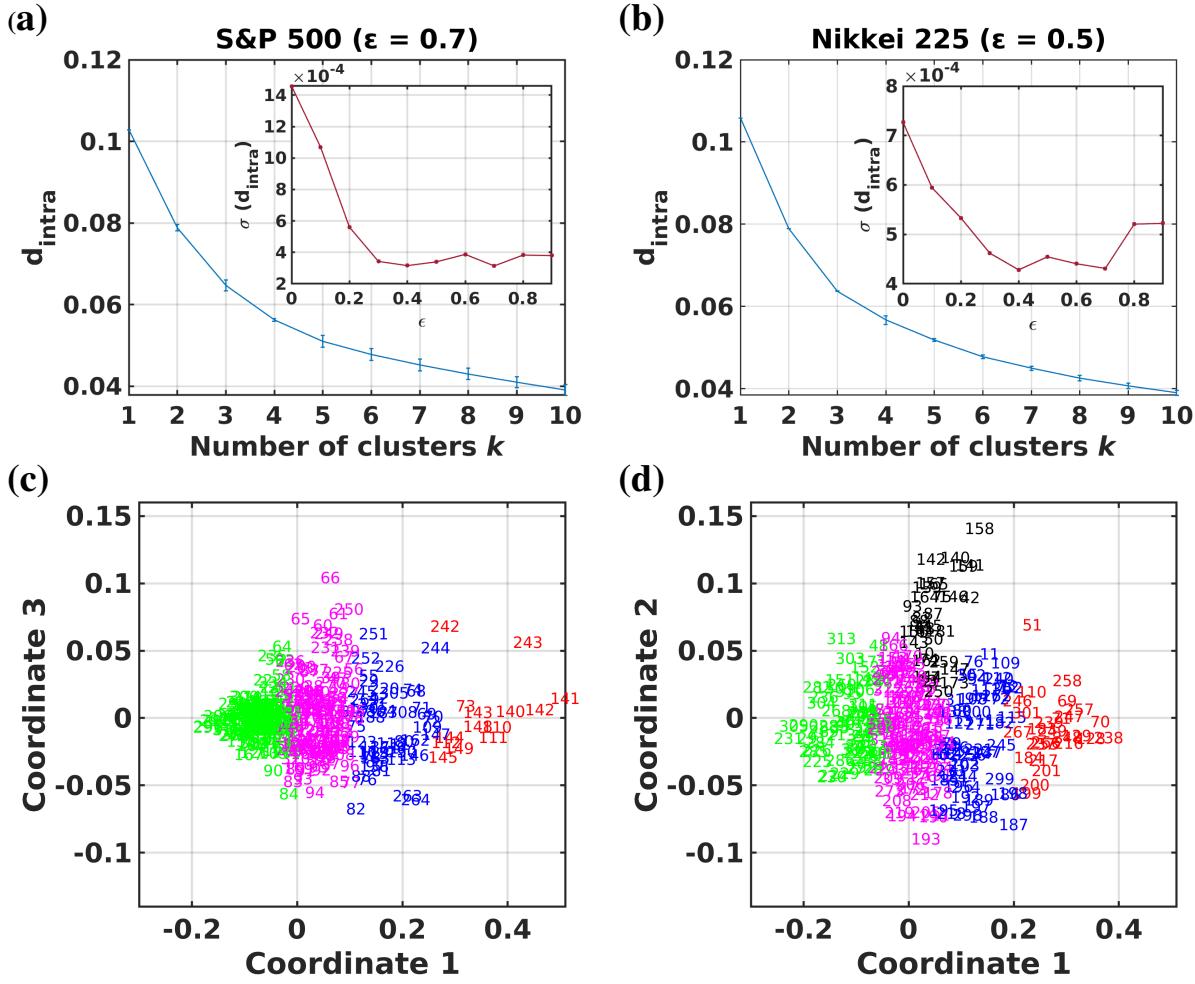
Figure S3. Classification of market states using optimal intra cluster distances d_{intra} for the S&P 500 and Nikkei 225. The measure of the d_{intra} calculated for different number of clusters is shown in (a) and (b) for the S&P 500 and Nikkei 225 over a period of 2006-2018, respectively. The plots show the minima of standard deviations of intracluster distance $\sigma(d_{intra})$ at $k = 4$ for S&P 500 and $k = 5$ for Nikkei 225, respectively, which correspond to the "optimal" number of clusters. k-means clustering is used to cluster the S&P 500 and Nikkei 225 in four and five number of cluster, respectively. The alignment of the clusters is different in two markets: clusters in (c) S&P 500 market are aligned along the average correlation and trivial but for (d) Nikkei 225 market one more cluster forms between second and fourth cluster with nearly same average correlation.

(a)

(b)
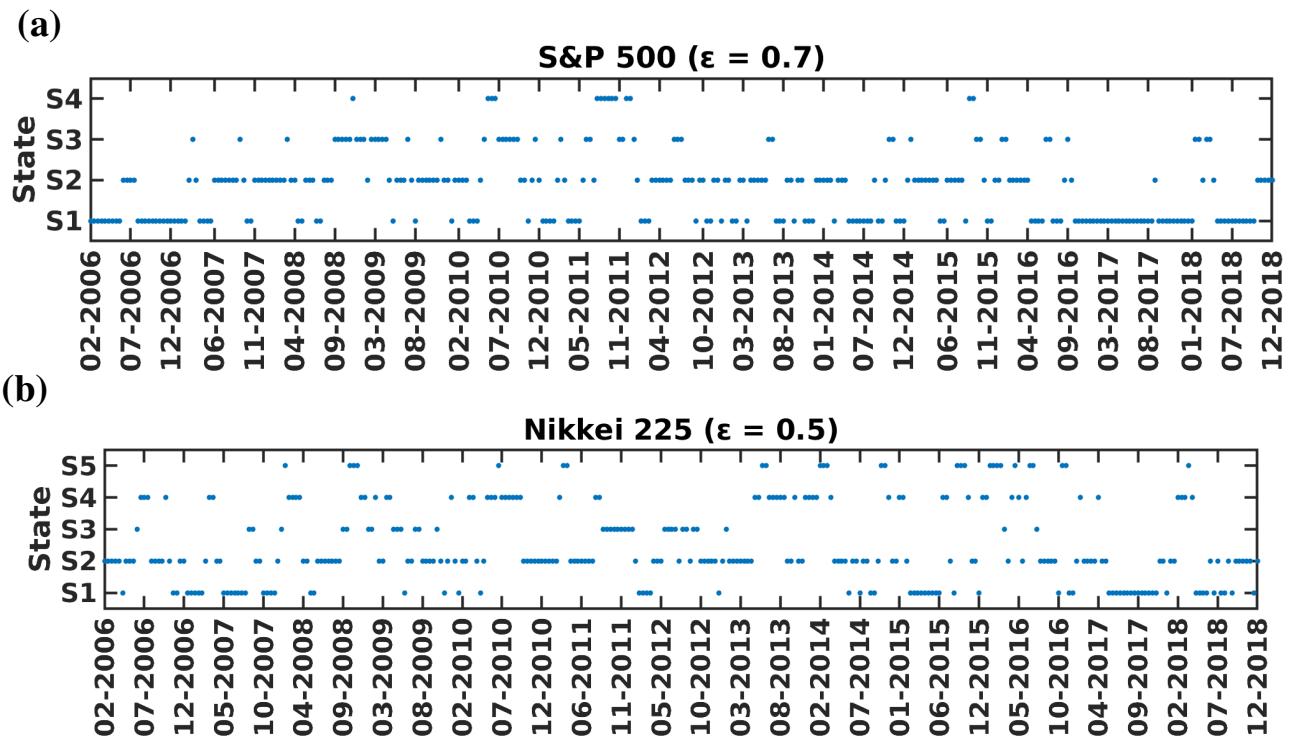
Figure S4. Market state dynamics of stock markets: (a) Evolution of S&P 500 market through the transitions among four different characterized states ($S1, S2, S3$, and $S4$) for the period of $2006 - 2018$ and (b) Evolution of Nikkei 225 market though the transitions among five different characterized states ($S1, S2, S3, S4$, and $S5$) for the period of $2006 - 2018$. The probability to remaining in the same state or transition to nearby states are relatively high.
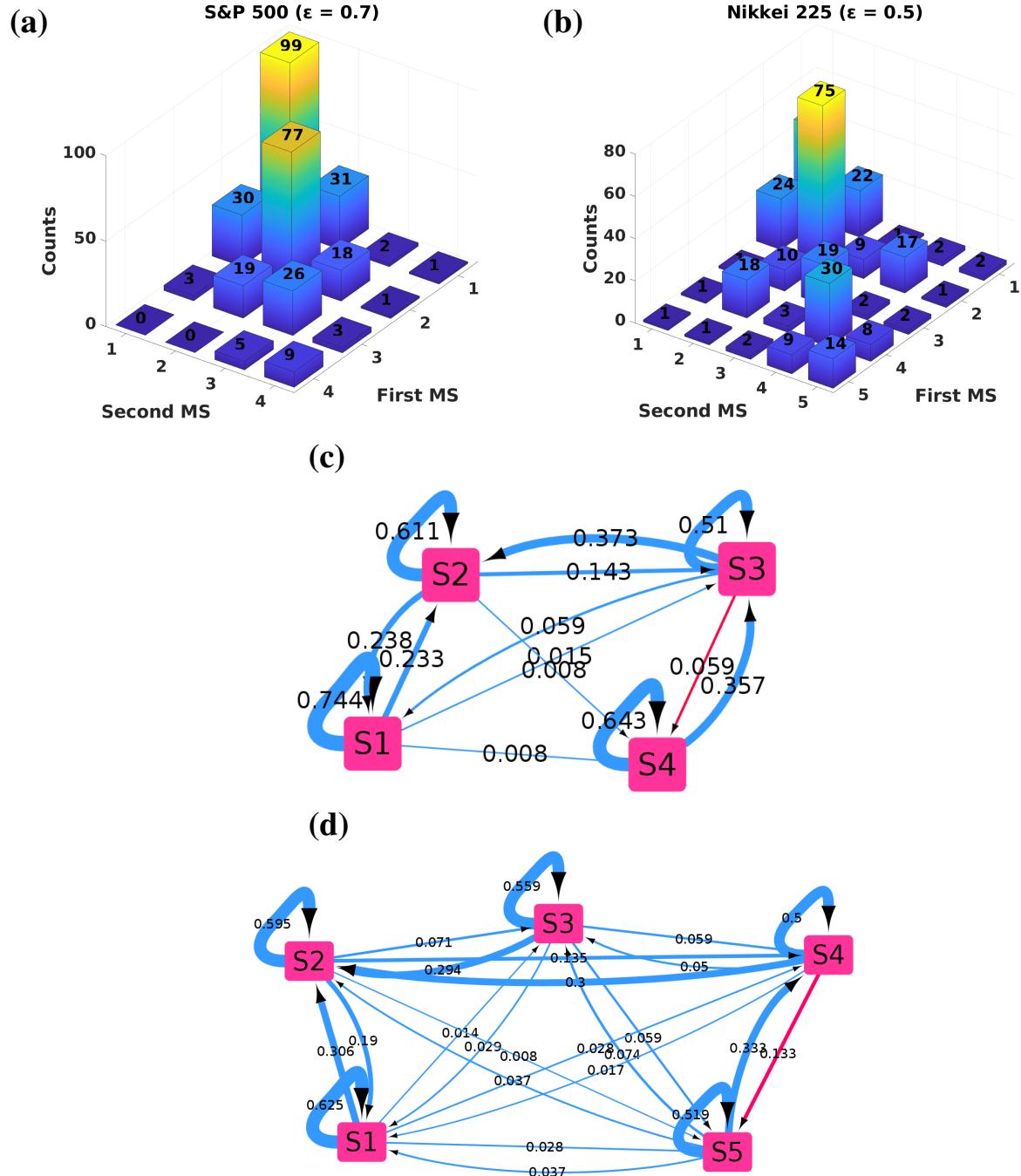
Figure S5. Bar plots of transition counts (frequencies) of paired market states (MS) for S&P 500 and Nikkei 225 are shown in (a) and (b), respectively. The networks plots of transition probabilities between different states of (c) S&P 500 and (d) Nikkei 225, respectively. The transition probability of market state transition of *S*3 to *S*4 is 6% for S&P 500 market, and similarly, for Nikkei 225, the probability of market state transition of *S*4 to *S*5 is 13%.
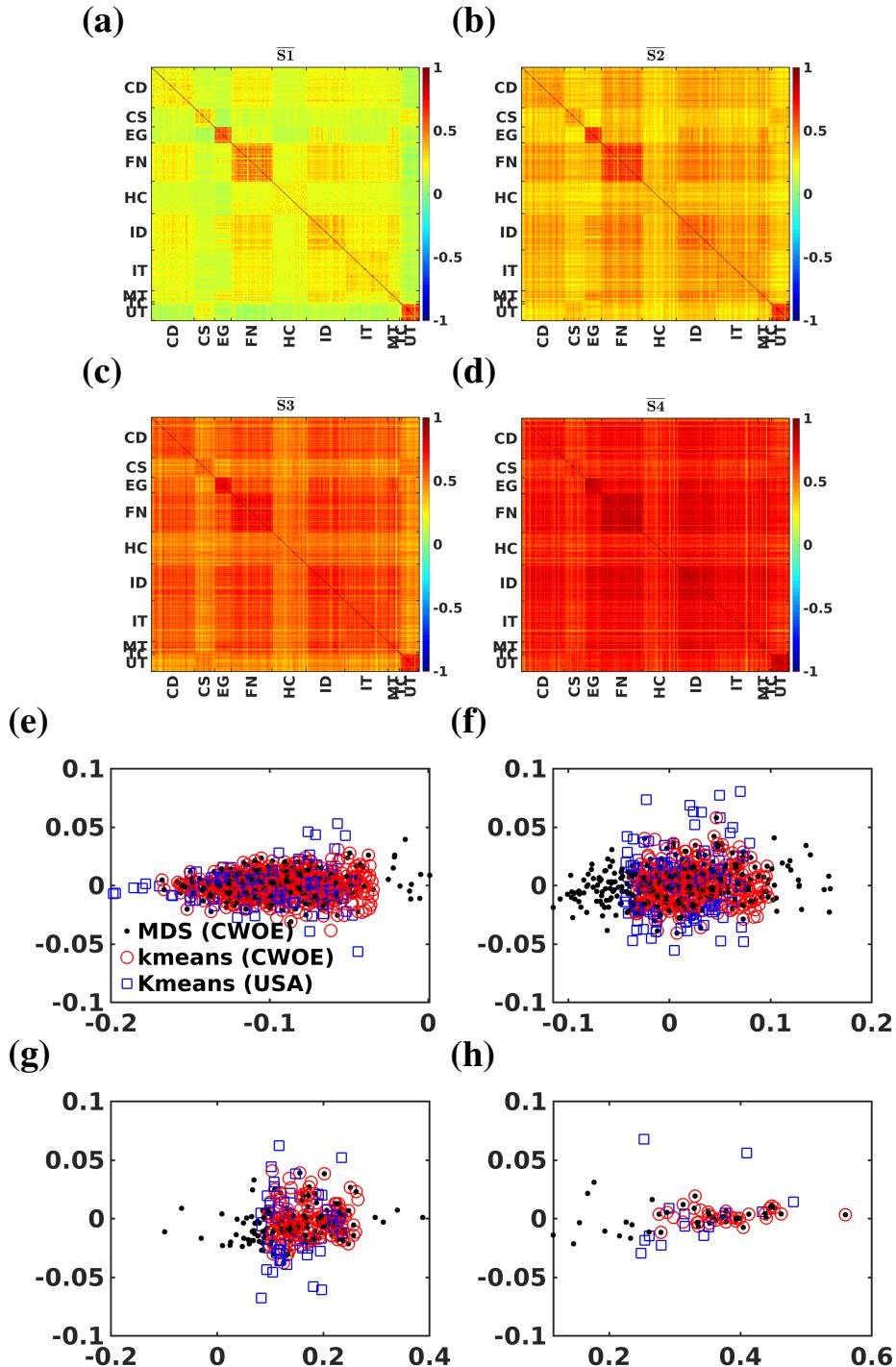
Figure S6. Average correlation of each market state of S&P 500 market and clustering of correlated Wishart orthogonal ensembles (CWOE). (a-d) show mean correlation matrices $\overline{Si}$ evaluated over all the frames correspond to each market state $S1, S2, S3, \& S4$ but for the original correlation matrices ($\varepsilon = 0$). It shows the average behavior of each market states of S&P 500 over a period of 13 years (2006-2018). (e) Dots (MDS (CWOE)) in the plot show the multidimensional scaling map of CWOE using mean correlations martix as $\overline{S1}$ and constructing three times bigger ensemble than $S1$ market state of the S&P 500 market with same noise-suppression $\varepsilon = 0.7$. Red circles (k-means (CWOE)) in plot show the points of the $S1$ cluster of k-means clustering performed on CWOE (dots). Blue squares (k-means (USA)) in the plot show the k-means clustering on the emperical data of S&P 500. k-means clustering on the CWOE and S&P 500 data shows qualitatively similar behavior. (f), (g), and (h) show the same using mean correlation matrices $\overline{S2}, \overline{S3}$, and $\overline{S4}$ states, respectively.
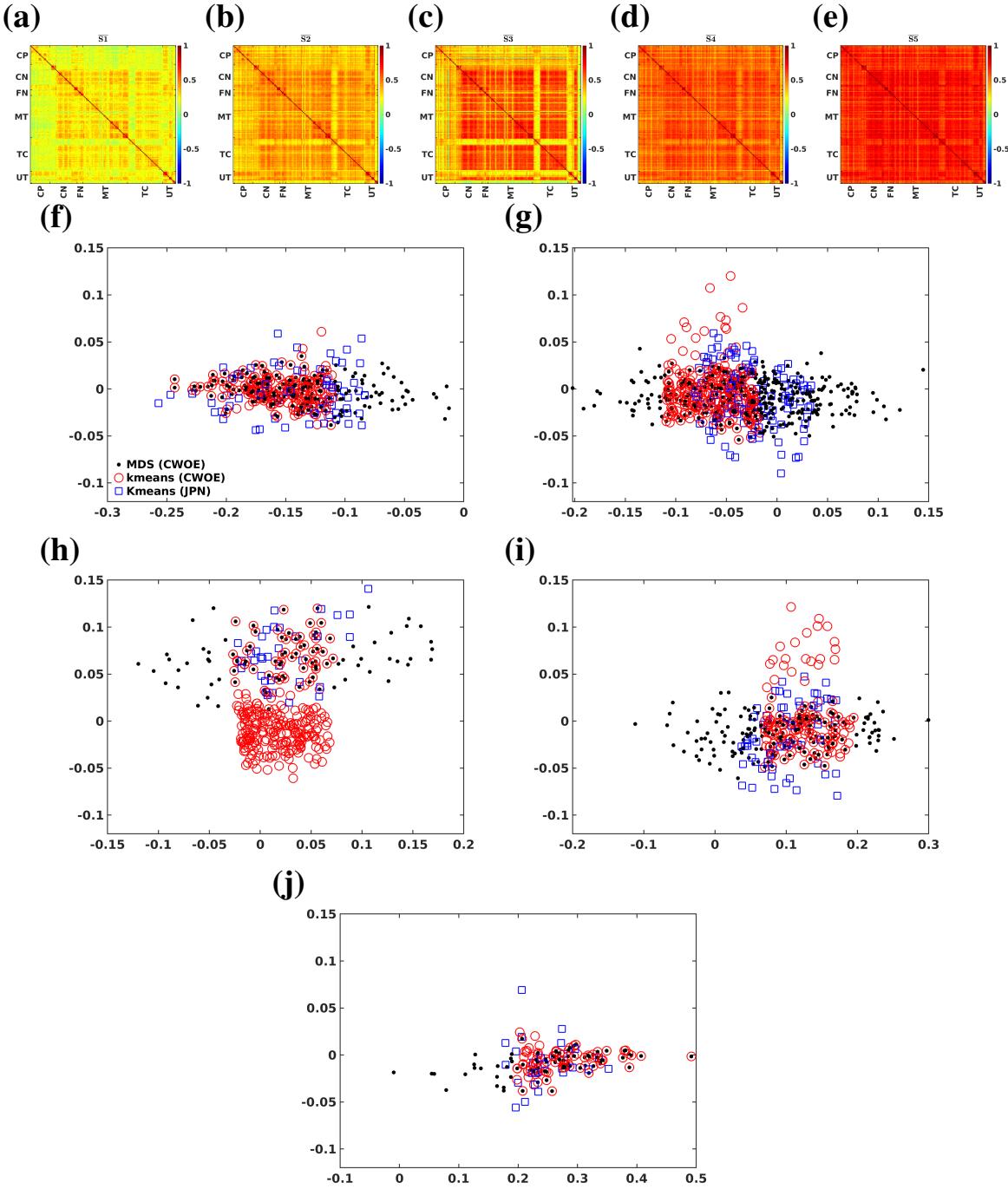
Figure S7. Average correlation of each market state of Nikkei 225 market and clustering of correlated Wishart orthogonal ensembles (CWOE). (a-e) show mean correlation matrices $\overline{Si}$ evaluated over all the frames correspond to each market state $S1, S2, S3, S4, \& S5$ but for the original correlation matrices ($\varepsilon = 0$). It shows the average behavior of each market states of S&P 500 over a period of 13 years (2006-2018). (f) Dots (MDS (CWOE)) in the plot show the multidimensional scaling map of CWOE using mean correlations martix as $\overline{S1}$ and constructing three times bigger ensemble than $S1$ market state of the S&P 500 market with same noise-suppression $\varepsilon = 0.7$. Red circles (k-means (CWOE)) in plot show the points of the $S1$ cluster of k-means clustering performed on CWOE (dots). Blue squares (k-means (USA)) in the plot show the k-means clustering on the emperical data of S&P 500. k-means clustering on the CWOE and S&P 500 data shows qualitatively similar behavior. (g), (h), (i), and (j) show the same using mean correlation matrices $\overline{S2}, \overline{S3}, \overline{S4}$, and $\overline{S5}$ states, respectively.

Table S3. List of 350 stocks of USA S&P 500 considered for the analysis present over the period of 2006-2019.

S.No.	Code	Company Name	Sector	Abbrv
1	AAP	Advance Auto Parts	Consumer Discretionary	CD
2	AMZN	Amazon.com Inc.	Consumer Discretionary	CD
3	AZO	AutoZone Inc	Consumer Discretionary	CD
4	BBY	Best Buy Co. Inc.	Consumer Discretionary	CD
5	BKNG	Booking Holdings Inc	Consumer Discretionary	CD
6	CCL	Carnival Corp.	Consumer Discretionary	CD
7	CMCSA	Comcast Corp.	Consumer Discretionary	CD
8	DHI	D. R. Horton	Consumer Discretionary	CD
9	DISCA	Discovery Inc. Class A	Consumer Discretionary	CD
10	DISH	Dish Network	Consumer Discretionary	CD
11	DLTR	Dollar Tree	Consumer Discretionary	CD
12	EXPE	Expedia Inc.	Consumer Discretionary	CD
13	F	Ford Motor	Consumer Discretionary	CD
14	GPC	Genuine Parts	Consumer Discretionary	CD
15	GPS	Gap Inc.	Consumer Discretionary	CD
16	GRMN	Garmin Ltd.	Consumer Discretionary	CD
17	HAS	Hasbro Inc.	Consumer Discretionary	CD
18	HD	Home Depot	Consumer Discretionary	CD
19	HOG	Harley-Davidson	Consumer Discretionary	CD
20	IPG	Interpublic Group	Consumer Discretionary	CD
21	JWN	Nordstrom	Consumer Discretionary	CD
22	KMX	Carmax Inc	Consumer Discretionary	CD
23	KSS	Kohl's Corp.	Consumer Discretionary	CD
24	LB	L Brands Inc.	Consumer Discretionary	CD
25	LEG	Leggett & Platt	Consumer Discretionary	CD
26	LEN	Lennar Corp.	Consumer Discretionary	CD
27	LKQ	LKQ Corporation	Consumer Discretionary	CD
28	LOW	Lowe's Cos.	Consumer Discretionary	CD
29	M	Macy's Inc.	Consumer Discretionary	CD
30	MAR	Marriott Int'l.	Consumer Discretionary	CD
31	MCD	McDonald's Corp.	Consumer Discretionary	CD
32	MGM	MGM Resorts International	Consumer Discretionary	CD
33	MHK	Mohawk Industries	Consumer Discretionary	CD
34	NKE	Nike	Consumer Discretionary	CD
35	NWL	Newell Brands	Consumer Discretionary	CD
36	OMC	Omnicom Group	Consumer Discretionary	CD
37	ORLY	O'Reilly Automotive	Consumer Discretionary	CD
38	PHM	Pulte Homes Inc.	Consumer Discretionary	CD
39	PVH	PVH Corp.	Consumer Discretionary	CD
40	RL	Polo Ralph Lauren Corp.	Consumer Discretionary	CD
41	ROST	Ross Stores	Consumer Discretionary	CD
42	SBUX	Starbucks Corp.	Consumer Discretionary	CD
43	SWK	Stanley Black & Decker	Consumer Discretionary	CD
44	TGT	Target Corp.	Consumer Discretionary	CD
45	TIF	Tiffany & Co.	Consumer Discretionary	CD
46	TJX	TJX Companies Inc.	Consumer Discretionary	CD
47	TPR	Tapestry, Inc.	Consumer Discretionary	CD
48	UAA	Under Armour Class A	Consumer Discretionary	CD
49	VFC	V.F. Corp.	Consumer Discretionary	CD
50	WHR	Whirlpool Corp.	Consumer Discretionary	CD

S.No.	Code	Company Name	Sector	Abbrv
51	WYNN	Wynn Resorts Ltd	Consumer Discretionary	CD
52	YUM	Yum! Brands Inc	Consumer Discretionary	CD
53	ADM	Archer-Daniels-Midland Co	Consumer Staples	CS
54	CAG	Conagra Brands	Consumer Staples	CS
55	CHD	Church & Dwight	Consumer Staples	CS
56	CL	Colgate-Palmolive	Consumer Staples	CS
57	CLX	The Clorox Company	Consumer Staples	CS
58	COST	Costco Wholesale Corp.	Consumer Staples	CS
59	CPB	Campbell Soup	Consumer Staples	CS
60	CVS	CVS Health	Consumer Staples	CS
61	EL	Estee Lauder Cos.	Consumer Staples	CS
62	GIS	General Mills	Consumer Staples	CS
63	HRL	Hormel Foods Corp.	Consumer Staples	CS
64	HSY	The Hershey Company	Consumer Staples	CS
65	K	Kellogg Co.	Consumer Staples	CS
66	KMB	Kimberly-Clark	Consumer Staples	CS
67	KO	Coca-Cola Company (The)	Consumer Staples	CS
68	KR	Kroger Co.	Consumer Staples	CS
69	MDLZ	Mondelez International	Consumer Staples	CS
70	MKC	McCormick & Co.	Consumer Staples	CS
71	MNST	Monster Beverage	Consumer Staples	CS
72	MO	Altria Group Inc	Consumer Staples	CS
73	PEP	PepsiCo Inc.	Consumer Staples	CS
74	PG	Procter & Gamble	Consumer Staples	CS
75	SJM	JM Smucker	Consumer Staples	CS
76	STZ	Constellation Brands	Consumer Staples	CS
77	SYY	Sysco Corp.	Consumer Staples	CS
78	TAP	Molson Coors Brewing Company	Consumer Staples	CS
79	TSN	Tyson Foods	Consumer Staples	CS
80	WBA	Walgreens Boots Alliance	Consumer Staples	CS
81	WMT	Wal-Mart Stores	Consumer Staples	CS
82	APA	Apache Corporation	Energy	EG
83	COG	Cabot Oil & Gas	Energy	EG
84	COP	ConocoPhillips	Energy	EG
85	CVX	Chevron Corp.	Energy	EG
86	DVN	Devon Energy Corp.	Energy	EG
87	EOG	EOG Resources	Energy	EG
88	FTI	TechnipFMC	Energy	EG
89	HAL	Halliburton Co.	Energy	EG
90	HES	Hess Corporation	Energy	EG
91	HP	Helmerich & Payne	Energy	EG
92	MRO	Marathon Oil Corp.	Energy	EG
93	NBL	Noble Energy Inc	Energy	EG
94	NOV	National Oilwell Varco Inc.	Energy	EG
95	OKE	ONEOK	Energy	EG
96	PXD	Pioneer Natural Resources	Energy	EG
97	SLB	Schlumberger Ltd.	Energy	EG
98	VLO	Valero Energy	Energy	EG
99	WMB	Williams Cos.	Energy	EG
100	XEC	Cimarex Energy	Energy	EG
101	XOM	Exxon Mobil Corp.	Energy	EG
102	AFL	AFLAC Inc	Financials	FN

S.No.	Code	Company Name	Sector	Abbrv
103	AIG	American International Group, Inc.	Financials	FN
104	AIZ	Assurant Inc.	Financials	FN
105	AJG	Arthur J. Gallagher & Co.	Financials	FN
106	AMG	Affiliated Managers Group Inc	Financials	FN
107	AMP	Ameriprise Financial	Financials	FN
108	AON	Aon plc	Financials	FN
109	AXP	American Express Co	Financials	FN
110	BAC	Bank of America Corp	Financials	FN
111	BEN	Franklin Resources	Financials	FN
112	BK	The Bank of New York Mellon Corp.	Financials	FN
113	BLK	BlackRock	Financials	FN
114	C	Citigroup Inc.	Financials	FN
115	CINF	Cincinnati Financial	Financials	FN
116	CMA	Comerica Inc.	Financials	FN
117	CME	CME Group Inc.	Financials	FN
118	ETFC	E*Trade	Financials	FN
119	FITB	Fifth Third Bancorp	Financials	FN
120	GS	Goldman Sachs Group	Financials	FN
121	HBAN	Huntington Bancshares	Financials	FN
122	HIG	Hartford Financial Svc.Gp.	Financials	FN
123	HRB	Block H&R	Financials	FN
124	ICE	Intercontinental Exchange	Financials	FN
125	IVZ	Invesco Ltd.	Financials	FN
126	JPM	JPMorgan Chase & Co.	Financials	FN
127	KEY	KeyCorp	Financials	FN
128	L	Loews Corp.	Financials	FN
129	LNC	Lincoln National	Financials	FN
130	MCO	Moody's Corp	Financials	FN
131	MET	MetLife Inc.	Financials	FN
132	MMC	Marsh & McLennan	Financials	FN
133	MS	Morgan Stanley	Financials	FN
134	MTB	M&T Bank Corp.	Financials	FN
135	NDAQ	Nasdaq, Inc.	Financials	FN
136	NTRS	Northern Trust Corp.	Financials	FN
137	PBCT	People's United Financial	Financials	FN
138	PFG	Principal Financial Group	Financials	FN
139	PGR	Progressive Corp.	Financials	FN
140	PNC	PNC Financial Services	Financials	FN
141	PRU	Prudential Financial	Financials	FN
142	RE	Everest Re Group Ltd.	Financials	FN
143	RF	Regions Financial Corp.	Financials	FN
144	RJF	Raymond James Financial Inc.	Financials	FN
145	SCHW	Charles Schwab Corporation	Financials	FN
146	SIVB	SVB Financial	Financials	FN
147	SPGI	S&P Global, Inc.	Financials	FN
148	STT	State Street Corp.	Financials	FN
149	TROW	T. Rowe Price Group	Financials	FN
150	TRV	The Travelers Companies Inc.	Financials	FN
151	UNM	Unum Group	Financials	FN
152	USB	U.S. Bancorp	Financials	FN
153	WFC	Wells Fargo	Financials	FN
154	WLTW	Willis Towers Watson	Financials	FN
155	ZION	Zions Bancorp	Financials	FN

S.No.	Code	Company Name	Sector	Abbrv
156	A	Agilent Technologies Inc	Health Care	HC
157	ABC	AmerisourceBergen Corp	Health Care	HC
158	ABT	Abbott Laboratories	Health Care	HC
159	AGN	Allergan, Plc	Health Care	HC
160	ALGN	Align Technology	Health Care	HC
161	ALXN	Alexion Pharmaceuticals	Health Care	HC
162	AMGN	Amgen Inc.	Health Care	HC
163	ANTM	Anthem Inc.	Health Care	HC
164	BAX	Baxter International Inc.	Health Care	HC
165	BDX	Becton Dickinson	Health Care	HC
166	BIIB	Biogen Inc.	Health Care	HC
167	BMY	Bristol-Myers Squibb	Health Care	HC
168	BSX	Boston Scientific	Health Care	HC
169	CERN	Cerner	Health Care	HC
170	CI	CIGNA Corp.	Health Care	HC
171	CNC	Centene Corporation	Health Care	HC
172	COO	The Cooper Companies	Health Care	HC
173	DGX	Quest Diagnostics	Health Care	HC
174	DVA	DaVita Inc.	Health Care	HC
175	EW	Edwards Lifesciences	Health Care	HC
176	GILD	Gilead Sciences	Health Care	HC
177	HOLX	Hologic	Health Care	HC
178	HSIC	Henry Schein	Health Care	HC
179	HUM	Humana Inc.	Health Care	HC
180	IDXX	IDEXX Laboratories	Health Care	HC
181	ILMN	Illumina Inc	Health Care	HC
182	INCY	Incyte	Health Care	HC
183	ISRG	Intuitive Surgical Inc.	Health Care	HC
184	JNJ	Johnson & Johnson	Health Care	HC
185	LH	Laboratory Corp. of America Holding	Health Care	HC
186	LLY	Lilly (Eli) & Co.	Health Care	HC
187	MDT	Medtronic plc	Health Care	HC
188	MRK	Merck & Co.	Health Care	HC
189	MTD	Mettler Toledo	Health Care	HC
190	MYL	Mylan N.V.	Health Care	HC
191	PFE	Pfizer Inc.	Health Care	HC
192	PKI	PerkinElmer	Health Care	HC
193	PRGO	Perrigo	Health Care	HC
194	REGN	Regeneron	Health Care	HC
195	RMD	ResMed	Health Care	HC
196	SYK	Stryker Corp.	Health Care	HC
197	TMO	Thermo Fisher Scientific	Health Care	HC
198	UHS	Universal Health Services, Inc.	Health Care	HC
199	UNH	United Health Group Inc.	Health Care	HC
200	VRTX	Vertex Pharmaceuticals Inc	Health Care	HC
201	WAT	Waters Corporation	Health Care	HC
202	XRAY	Dentsply Sirona	Health Care	HC
203	ZBH	Zimmer Biomet Holdings	Health Care	HC
204	AAL	American Airlines Group	Industrials	ID
205	ALK	Alaska Air Group Inc	Industrials	ID
206	AME	AMETEK Inc.	Industrials	ID

S.No.	Code	Company Name	Sector	Abbrv
207	AOS	A.O. Smith Corp	Industrials	ID
208	ARNC	Arconic Inc.	Industrials	ID
209	BA	Boeing Company	Industrials	ID
210	CAT	Caterpillar Inc.	Industrials	ID
211	CHRW	C. H. Robinson Worldwide	Industrials	ID
212	CMI	Cummins Inc.	Industrials	ID
213	CSX	CSX Corp.	Industrials	ID
214	CTAS	Cintas Corporation	Industrials	ID
215	DE	Deere & Co.	Industrials	ID
216	DOV	Dover Corp.	Industrials	ID
217	EFX	Equifax Inc.	Industrials	ID
218	EMR	Emerson Electric Company	Industrials	ID
219	ETN	Eaton Corporation	Industrials	ID
220	EXPD	Expeditors International	Industrials	ID
221	FAST	Fastenal Co	Industrials	ID
222	FDX	FedEx Corporation	Industrials	ID
223	FLS	Flowserve Corporation	Industrials	ID
224	GD	General Dynamics	Industrials	ID
225	GE	General Electric	Industrials	ID
226	GWW	Grainger (W.W.) Inc.	Industrials	ID
227	IR	Ingersoll-Rand PLC	Industrials	ID
228	ITW	Illinois Tool Works	Industrials	ID
229	JBHT	J. B. Hunt Transport Services	Industrials	ID
230	JCI	Johnson Controls International	Industrials	ID
231	KSU	Kansas City Southern	Industrials	ID
232	LMT	Lockheed Martin Corp.	Industrials	ID
233	LUV	Southwest Airlines	Industrials	ID
234	MAS	Masco Corp.	Industrials	ID
235	NOC	Northrop Grumman Corp.	Industrials	ID
236	NSC	Norfolk Southern Corp.	Industrials	ID
237	PCAR	PACCAR Inc.	Industrials	ID
238	PH	Parker-Hannifin	Industrials	ID
239	PNR	Pentair Ltd.	Industrials	ID
240	PWR	Quanta Services Inc.	Industrials	ID
241	RHI	Robert Half International	Industrials	ID
242	ROK	Rockwell Automation Inc.	Industrials	ID
243	ROP	Roper Technologies	Industrials	ID
244	RSG	Republic Services Inc	Industrials	ID
245	RTN	Raytheon Co.	Industrials	ID
246	TXT	Textron Inc.	Industrials	ID
247	UNP	Union Pacific	Industrials	ID
248	UPS	United Parcel Service	Industrials	ID
249	URI	United Rentals, Inc.	Industrials	ID
250	UTX	United Technologies	Industrials	ID
251	WM	Waste Management Inc.	Industrials	ID
252	AAPL	Apple Inc.	Information Technology	IT
253	ACN	Accenture plc	Information Technology	IT
254	ADBE	Adobe Systems Inc	Information Technology	IT
255	ADI	Analog Devices, Inc.	Information Technology	IT
256	ADP	Automatic Data Processing	Information Technology	IT
257	ADS	Alliance Data Systems	Information Technology	IT
258	ADSK	Autodesk Inc.	Information Technology	IT

S.No.	Code	Company Name	Sector	Abbrv
259	AKAM	Akamai Technologies Inc	Information Technology	IT
260	AMAT	Applied Materials Inc.	Information Technology	IT
261	AMD	Advanced Micro Devices Inc	Information Technology	IT
262	ANSS	ANSYS	Information Technology	IT
263	APH	Amphenol Corp	Information Technology	IT
264	ATVI	Activision Blizzard	Information Technology	IT
265	CDNS	Cadence Design Systems	Information Technology	IT
266	CRM	Salesforce.com	Information Technology	IT
267	CSCO	Cisco Systems	Information Technology	IT
268	CTSH	Cognizant Technology Solutions	Information Technology	IT
269	CTXS	Citrix Systems	Information Technology	IT
270	DXC	DXC Technology	Information Technology	IT
271	EA	Electronic Arts	Information Technology	IT
272	EBAY	eBay Inc.	Information Technology	IT
273	FFIV	F5 Networks	Information Technology	IT
274	FIS	Fidelity National Information Services	Information Technology	IT
275	FISV	Fiserv Inc	Information Technology	IT
276	FLIR	FLIR Systems	Information Technology	IT
277	GLW	Corning Inc.	Information Technology	IT
278	GOOG	Alphabet Inc Class C	Information Technology	IT
279	GOOGL	Alphabet Inc Class A	Information Technology	IT
280	GPN	Global Payments Inc.	Information Technology	IT
281	HPQ	HP Inc.	Information Technology	IT
282	IBM	International Business Machines	Information Technology	IT
283	INTC	Intel Corp.	Information Technology	IT
284	INTU	Intuit Inc.	Information Technology	IT
285	IT	Gartner Inc	Information Technology	IT
286	JNPR	Juniper Networks	Information Technology	IT
287	KLAC	KLA-Tencor Corp.	Information Technology	IT
288	LRCX	Lam Research	Information Technology	IT
289	MCHP	Microchip Technology	Information Technology	IT
290	MSFT	Microsoft Corp.	Information Technology	IT
291	MSI	Motorola Solutions Inc.	Information Technology	IT
292	MU	Micron Technology	Information Technology	IT
293	NFLX	Netflix Inc.	Information Technology	IT
294	NTAP	NetApp	Information Technology	IT
295	NVDA	Nvidia Corporation	Information Technology	IT
296	ORCL	Oracle Corp.	Information Technology	IT
297	PAYX	Paychex Inc.	Information Technology	IT
298	QCOM	QUALCOMM Inc.	Information Technology	IT
299	SNPS	Synopsys Inc.	Information Technology	IT
300	STX	Seagate Technology	Information Technology	IT
301	SWKS	Skyworks Solutions	Information Technology	IT
302	TTWO	Take-Two Interactive	Information Technology	IT
303	TXN	Texas Instruments	Information Technology	IT
304	VRSN	Verisign Inc.	Information Technology	IT
305	WDC	Western Digital	Information Technology	IT
306	XLNX	Xilinx Inc	Information Technology	IT
307	APD	Air Products & Chemicals Inc	Materials	MT
308	AVY	Avery Dennison Corp	Materials	MT
309	BLL	Ball Corp	Materials	MT

S.No.	Code	Company Name	Sector	Abbrv
310	CF	CF Industries Holdings Inc	Materials	MT
311	ECL	Ecolab Inc.	Materials	MT
312	FCX	Freeport-McMoRan Inc.	Materials	MT
313	FMC	FMC Corporation	Materials	MT
314	IFF	Intl Flavors & Fragrances	Materials	MT
315	IP	International Paper	Materials	MT
316	MOS	The Mosaic Company	Materials	MT
317	NEM	Newmont Mining Corporation	Materials	MT
318	NUE	Nucor Corp.	Materials	MT
319	PKG	Packaging Corporation of America	Materials	MT
320	PPG	PPG Industries	Materials	MT
321	SEE	Sealed Air	Materials	MT
322	SHW	Sherwin-Williams	Materials	MT
323	VMC	Vulcan Materials	Materials	MT
324	CTL	CenturyLink Inc	Telecommunication Services	TC
325	T	AT&T Inc.	Telecommunication Services	TC
326	VZ	Verizon Communications	Telecommunication Services	TC
327	AEE	Ameren Corp	Utilities	UT
328	AEP	American Electric Power	Utilities	UT
329	AES	AES Corp	Utilities	UT
330	CMS	CMS Energy	Utilities	UT
331	CNP	CenterPoint Energy	Utilities	UT
332	D	Dominion Energy	Utilities	UT
333	DTE	DTE Energy Co.	Utilities	UT
334	DUK	Duke Energy	Utilities	UT
335	ED	Consolidated Edison	Utilities	UT
336	EIX	Edison Int'l	Utilities	UT
337	ES	Eversource Energy	Utilities	UT
338	ETR	Entergy Corp.	Utilities	UT
339	EXC	Exelon Corp.	Utilities	UT
340	FE	FirstEnergy Corp	Utilities	UT
341	LNT	Alliant Energy Corp	Utilities	UT
342	NEE	NextEra Energy	Utilities	UT
343	NI	NiSource Inc.	Utilities	UT
344	NRG	NRG Energy	Utilities	UT
345	PEG	Public Serv. Enterprise Inc.	Utilities	UT
346	PNW	Pinnacle West Capital	Utilities	UT
347	SO	Southern Co.	Utilities	UT
348	SRE	Sempra Energy	Utilities	UT
349	WEC	Wec Energy Group Inc	Utilities	UT
350	XEL	Xcel Energy Inc	Utilities	UT

Table S4. List of 156 stocks of JPN Nikkei 225 considered for the analysis present over the period of 2006-2019.

S.No.	Code	Company Name	Sector	Abbrv
1	1332.T	NIPPON SUISAN KAISHA, LTD.	Consumer Goods	CG
2	2002.T	NISSHIN SEIFUN GROUP INC.	Consumer Goods	CG
3	2282.T	NH FOODS LTD.	Consumer Goods	CG
4	2502.T	ASAHI GROUP HOLDINGS, LTD.	Consumer Goods	CG
5	2503.T	KIRIN HOLDINGS CO., LTD.	Consumer Goods	CG
6	2531.T	TAKARA HOLDINGS INC.	Consumer Goods	CG
7	2801.T	KIKKOMAN CORP.	Consumer Goods	CG
8	2802.T	AJINOMOTO CO., INC.	Consumer Goods	CG
9	2871.T	NICHIREI CORP.	Consumer Goods	CG
10	3086.T	J.FRONT RETAILING CO., LTD.	Consumer Goods	CG
11	3099.T	ISETAN MITSUKOSHI HOLDINGS LTD.	Consumer Goods	CG
12	4704.T	TREND MICRO INC.	Consumer Goods	CG
13	8028.T	FAMILYMART UNY HOLDINGS CO., LTD.	Consumer Goods	CG
14	8233.T	TAKASHIMAYA CO., LTD.	Consumer Goods	CG
15	8267.T	AEON CO., LTD.	Consumer Goods	CG
16	9602.T	TOHO CO., LTD	Consumer Goods	CG
17	9681.T	TOKYO DOME CORP.	Consumer Goods	CG
18	9766.T	KONAMI HOLDINGS CORP.	Consumer Goods	CG
19	9983.T	FAST RETAILING CO., LTD.	Consumer Goods	CG
20	1721.T	COMSYS HOLDINGS CORP.	Capital Goods/Others	CP
21	1801.T	TAISEI CORP.	Capital Goods/Others	CP
22	1803.T	SHIMIZU CORP.	Capital Goods/Others	CP
23	1808.T	HASEKO CORP.	Capital Goods/Others	CP
24	1812.T	KAJIMA CORP.	Capital Goods/Others	CP
25	1928.T	SEKISUI HOUSE, LTD.	Capital Goods/Others	CP
26	1963.T	JGC CORP.	Capital Goods/Others	CP
27	5631.T	THE JAPAN STEEL WORKS, LTD.	Capital Goods/Others	CP
28	6113.T	AMADA HOLDINGS CO., LTD.	Capital Goods/Others	CP
29	6301.T	KOMATSU LTD.	Capital Goods/Others	CP
30	6302.T	SUMITOMO HEAVY IND., LTD.	Capital Goods/Others	CP
31	6305.T	HITACHI CONST. MACH. CO., LTD.	Capital Goods/Others	CP
32	6326.T	KUBOTA CORP.	Capital Goods/Others	CP
33	6361.T	EBARA CORP.	Capital Goods/Others	CP
34	6366.T	CHIYODA CORP.	Capital Goods/Others	CP
35	6367.T	DAIKIN INDUSTRIES, LTD.	Capital Goods/Others	CP
36	6471.T	NSK LTD.	Capital Goods/Others	CP
37	6472.T	NTN CORP.	Capital Goods/Others	CP
38	7003.T	MITSUI E&S HOLDINGS CO., LTD.	Capital Goods/Others	CP
39	7004.T	HITACHI ZOSEN CORP.	Capital Goods/Others	CP
40	7011.T	MITSUBISHI HEAVY IND., LTD.	Capital Goods/Others	CP
41	7012.T	KAWASAKI HEAVY IND., LTD.	Capital Goods/Others	CP
42	7013.T	IHI CORP.	Capital Goods/Others	CP
43	7912.T	DAI NIPPON PRINTING CO., LTD.	Capital Goods/Others	CP
44	7951.T	YAMAHA CORP.	Capital Goods/Others	CP
45	8801.T	MITSUI FUDOSAN CO., LTD.	Capital Goods/Others	CP
46	8802.T	MITSUBISHI ESTATE CO., LTD.	Capital Goods/Others	CP
47	8804.T	TOKYO TATEMONO CO., LTD.	Capital Goods/Others	CP
48	8830.T	SUMITOMO REALTY & DEVELOPMENT CO., LTD.	Capital Goods/Others	CP
49	8253.T	CREDIT SAISON CO., LTD.	Financials	FN
50	8331.T	THE CHIBA BANK, LTD.	Financials	FN
51	8355.T	THE SHIZUOKA BANK, LTD.	Financials	FN

S.No.	Code	Company Name	Sector	Abbrv
52	8601.T	DAIWA SECURITIES GROUP INC.	Financials	FN
53	8604.T	NOMURA HOLDINGS, INC.	Financials	FN
54	2768.T	SOJITZ CORP.	Materials	MT
55	3101.T	TOYOBO CO., LTD.	Materials	MT
56	3103.T	UNITIKA, LTD.	Materials	MT
57	3401.T	TEIJIN LTD.	Materials	MT
58	3402.T	TORAY INDUSTRIES, INC.	Materials	MT
59	3405.T	KURARAY CO., LTD.	Materials	MT
60	3407.T	ASAHI KASEI CORP.	Materials	MT
61	3861.T	OJI HOLDINGS CORP.	Materials	MT
62	4004.T	SHOWA DENKO K.K.	Materials	MT
63	4005.T	SUMITOMO CHEMICAL CO., LTD.	Materials	MT
64	4021.T	NISSAN CHEMICAL CORP.	Materials	MT
65	4042.T	TOSOH CORP.	Materials	MT
66	4061.T	DENKA CO., LTD.	Materials	MT
67	4063.T	SHIN-ETSU CHEMICAL CO., LTD.	Materials	MT
68	4183.T	MITSUI CHEMICALS, INC.	Materials	MT
69	4208.T	UBE INDUSTRIES, LTD.	Materials	MT
70	4272.T	NIPPON KAYAKU CO., LTD.	Materials	MT
71	4452.T	KAO CORP.	Materials	MT
72	4631.T	DIC CORP.	Materials	MT
73	4901.T	FUJIFILM HOLDINGS CORP.	Materials	MT
74	4911.T	SHISEIDO CO., LTD.	Materials	MT
75	5101.T	THE YOKOHAMA RUBBER CO., LTD.	Materials	MT
76	5108.T	BRIDGESTONE CORP.	Materials	MT
77	5202.T	NIPPON SHEET GLASS CO., LTD.	Materials	MT
78	5232.T	SUMITOMO OSAKA CEMENT CO., LTD.	Materials	MT
79	5233.T	TAIHEIYO CEMENT CORP.	Materials	MT
80	5301.T	TOKAI CARBON CO., LTD.	Materials	MT
81	5333.T	NGK INSULATORS, LTD.	Materials	MT
82	5401.T	NIPPON STEEL CORP.	Materials	MT
83	5406.T	KOBE STEEL, LTD.	Materials	MT
84	5541.T	PACIFIC METALS CO., LTD.	Materials	MT
85	5703.T	NIPPON LIGHT METAL HOLDINGS CO., LTD.	Materials	MT
86	5706.T	MITSUI MINING & SMELTING CO.	Materials	MT
87	5707.T	TOHO ZINC CO., LTD.	Materials	MT
88	5711.T	MITSUBISHI MATERIALS CORP.	Materials	MT
89	5713.T	SUMITOMO METAL MINING CO., LTD.	Materials	MT
90	5714.T	DOWA HOLDINGS CO., LTD.	Materials	MT
91	5801.T	FURUKAWA ELECTRIC CO., LTD.	Materials	MT
92	5802.T	SUMITOMO ELECTRIC IND., LTD.	Materials	MT
93	5803.T	FUJIKURA LTD.	Materials	MT
94	5901.T	TOYO SEIKAN GROUP HOLDINGS, LTD.	Materials	MT
95	6988.T	NITTO DENKO CORP.	Materials	MT
96	8001.T	ITOCHU CORP.	Materials	MT
97	8002.T	MARUBENI CORP.	Materials	MT
98	8015.T	TOYOTA TSUSHO CORP.	Materials	MT
99	8031.T	MITSUI & CO., LTD.	Materials	MT
100	8053.T	SUMITOMO CORP.	Materials	MT
101	8058.T	MITSUBISHI CORP.	Materials	MT
102	3105.T	NISSHINBO HOLDINGS INC.	Technology	TC
103	4151.T	KYOWA KIRIN CO., LTD.	Technology	TC
104	4502.T	TAKEDA PHARMACEUTICAL CO., LTD.	Technology	TC

S.No.	Code	Company Name	Sector	Abbrv
105	4503.T	ASTELLAS PHARMA INC.	Technology	TC
106	4506.T	SUMITOMO DAINIPPON PHARMA CO., LTD.	Technology	TC
107	4507.T	SHIONOGI & CO., LTD.	Technology	TC
108	4519.T	CHUGAI PHARMACEUTICAL CO., LTD.	Technology	TC
109	4543.T	TERUMO CORP.	Technology	TC
110	4902.T	KONICA MINOLTA, INC.	Technology	TC
111	6479.T	MINEBEA MITSUMI INC.	Technology	TC
112	6503.T	MITSUBISHI ELECTRIC CORP.	Technology	TC
113	6504.T	FUJI ELECTRIC CO., LTD.	Technology	TC
114	6506.T	YASKAWA ELECTRIC CORP.	Technology	TC
115	6701.T	NEC CORP.	Technology	TC
116	6702.T	FUJITSU LTD.	Technology	TC
117	6703.T	OKI ELECTRIC IND. CO., LTD.	Technology	TC
118	6724.T	SEIKO EPSON CORP.	Technology	TC
119	6758.T	SONY CORP.	Technology	TC
120	6762.T	TDK CORP.	Technology	TC
121	6770.T	ALPS ALPINE CO., LTD.	Technology	TC
122	6841.T	YOKOGAWA ELECTRIC CORP.	Technology	TC
123	6902.T	DENSO CORP.	Technology	TC
124	6952.T	CASIO COMPUTER CO., LTD.	Technology	TC
125	6954.T	FANUC CORP.	Technology	TC
126	6976.T	TAIYO YUDEN CO., LTD.	Technology	TC
127	7201.T	NISSAN MOTOR CO., LTD.	Technology	TC
128	7202.T	ISUZU MOTORS LTD.	Technology	TC
129	7203.T	TOYOTA MOTOR CORP.	Technology	TC
130	7205.T	HINO MOTORS, LTD.	Technology	TC
131	7211.T	MITSUBISHI MOTORS CORP.	Technology	TC
132	7261.T	MAZDA MOTOR CORP.	Technology	TC
133	7269.T	SUZUKI MOTOR CORP.	Technology	TC
134	7270.T	SUBARU CORP.	Technology	TC
135	7272.T	YAMAHA MOTOR CO., LTD.	Technology	TC
136	7731.T	NIKON CORP.	Technology	TC
137	7733.T	OLYMPUS CORP.	Technology	TC
138	7735.T	SCREEN HOLDINGS CO., LTD.	Technology	TC
139	7752.T	RICOH CO., LTD.	Technology	TC
140	8035.T	TOKYO ELECTRON LTD.	Technology	TC
141	9001.T	TOBU RAILWAY CO., LTD.	Transportation and Utilities	UT
142	9005.T	TOKYU CORP.	Transportation and Utilities	UT
143	9007.T	ODAKYU ELECTRIC RAILWAY CO., LTD.	Transportation and Utilities	UT
144	9008.T	KEIO CORP.	Transportation and Utilities	UT
145	9009.T	KEISEI ELECTRIC RAILWAY CO., LTD.	Transportation and Utilities	UT
146	9062.T	NIPPON EXPRESS CO., LTD.	Transportation and Utilities	UT
147	9064.T	YAMATO HOLDINGS CO., LTD.	Transportation and Utilities	UT
148	9101.T	NIPPON YUSEN K.K.	Transportation and Utilities	UT
149	9104.T	MITSUI O.S.K.LINES, LTD.	Transportation and Utilities	UT
150	9107.T	KAWASAKI KISEN KAISHA, LTD.	Transportation and Utilities	UT
151	9301.T	MITSUBISHI LOGISTICS CORP.	Transportation and Utilities	UT
152	9501.T	TOKYO ELECTRIC POWER COMPANY HOLDINGS, I	Transportation and Utilities	UT
153	9502.T	CHUBU ELECTRIC POWER CO., INC.	Transportation and Utilities	UT
154	9503.T	THE KANSAI ELECTRIC POWER CO., INC.	Transportation and Utilities	UT
155	9531.T	TOKYO GAS CO., LTD.	Transportation and Utilities	UT
156	9532.T	OSAKA GAS CO., LTD.	Transportation and Utilities	UT

Table S5. List of 368 stocks of USA S&P 500 considered for the analysis present over the period of 2006-2018.

S.No.	Code	Company Name	Sector	Abbrv
1	AAP	Advance Auto Parts	Consumer Discretionary	CD
2	AMZN	Amazon.com Inc.	Consumer Discretionary	CD
3	AZO	AutoZone Inc	Consumer Discretionary	CD
4	BBY	Best Buy Co. Inc.	Consumer Discretionary	CD
5	BKNG	Booking Holdings Inc	Consumer Discretionary	CD
6	CBS	CBS Corp.	Consumer Discretionary	CD
7	CCL	Carnival Corp.	Consumer Discretionary	CD
8	CMCSA	Comcast Corp.	Consumer Discretionary	CD
9	DHI	D. R. Horton	Consumer Discretionary	CD
10	DISCA	Discovery Inc. Class A	Consumer Discretionary	CD
11	DISH	Dish Network	Consumer Discretionary	CD
12	DLTR	Dollar Tree	Consumer Discretionary	CD
13	EXPE	Expedia Inc.	Consumer Discretionary	CD
14	F	Ford Motor	Consumer Discretionary	CD
15	FL	Foot Locker Inc	Consumer Discretionary	CD
16	FOX	Twenty-First Century Fox Class B	Consumer Discretionary	CD
17	FOXA	Twenty-First Century Fox Class A	Consumer Discretionary	CD
18	GPC	Genuine Parts	Consumer Discretionary	CD
19	GPS	Gap Inc.	Consumer Discretionary	CD
20	GRMN	Garmin Ltd.	Consumer Discretionary	CD
21	GT	Goodyear Tire & Rubber	Consumer Discretionary	CD
22	HAS	Hasbro Inc.	Consumer Discretionary	CD
23	HD	Home Depot	Consumer Discretionary	CD
24	HOG	Harley-Davidson	Consumer Discretionary	CD
25	IPG	Interpublic Group	Consumer Discretionary	CD
26	JWN	Nordstrom	Consumer Discretionary	CD
27	KSS	Kohl's Corp.	Consumer Discretionary	CD
28	LB	L Brands Inc.	Consumer Discretionary	CD
29	LEG	Leggett & Platt	Consumer Discretionary	CD
30	LEN	Lennar Corp.	Consumer Discretionary	CD
31	LKQ	LKQ Corporation	Consumer Discretionary	CD
32	LOW	Lowe's Cos.	Consumer Discretionary	CD
33	M	Macy's Inc.	Consumer Discretionary	CD
34	MAR	Marriott Int'l.	Consumer Discretionary	CD
35	MAT	Mattel Inc.	Consumer Discretionary	CD
36	MCD	McDonald's Corp.	Consumer Discretionary	CD
37	MGM	MGM Resorts International	Consumer Discretionary	CD
38	MHK	Mohawk Industries	Consumer Discretionary	CD
39	NKE	Nike	Consumer Discretionary	CD
40	NWL	Newell Brands	Consumer Discretionary	CD
41	OMC	Omnicom Group	Consumer Discretionary	CD
42	ORLY	O'Reilly Automotive	Consumer Discretionary	CD
43	PHM	Pulte Homes Inc.	Consumer Discretionary	CD
44	PVH	PVH Corp.	Consumer Discretionary	CD
45	RL	Polo Ralph Lauren Corp.	Consumer Discretionary	CD
46	ROST	Ross Stores	Consumer Discretionary	CD
47	SBUX	Starbucks Corp.	Consumer Discretionary	CD
48	SNA	Snap-On Inc.	Consumer Discretionary	CD
49	SWK	Stanley Black & Decker	Consumer Discretionary	CD
50	TGT	Target Corp.	Consumer Discretionary	CD
51	TIF	Tiffany & Co.	Consumer Discretionary	CD

S.No.	Code	Company Name	Sector	Abbrv
52	TJX	TJX Companies Inc.	Consumer Discretionary	CD
53	TPR	Tapestry, Inc.	Consumer Discretionary	CD
54	UAA	Under Armour Class A	Consumer Discretionary	CD
55	VFC	V.F. Corp.	Consumer Discretionary	CD
56	VIAB	Viacom Inc.	Consumer Discretionary	CD
57	WHR	Whirlpool Corp.	Consumer Discretionary	CD
58	WYNN	Wynn Resorts Ltd	Consumer Discretionary	CD
59	YUM	Yum! Brands Inc	Consumer Discretionary	CD
60	ADM	Archer-Daniels-Midland Co	Consumer Staples	CS
61	CAG	Conagra Brands	Consumer Staples	CS
62	CHD	Church & Dwight	Consumer Staples	CS
63	CL	Colgate-Palmolive	Consumer Staples	CS
64	CLX	The Clorox Company	Consumer Staples	CS
65	CPB	Campbell Soup	Consumer Staples	CS
66	CVS	CVS Health	Consumer Staples	CS
67	EL	Estee Lauder Cos.	Consumer Staples	CS
68	GIS	General Mills	Consumer Staples	CS
69	HRL	Hormel Foods Corp.	Consumer Staples	CS
70	HSY	The Hershey Company	Consumer Staples	CS
71	K	Kellogg Co.	Consumer Staples	CS
72	KMB	Kimberly-Clark	Consumer Staples	CS
73	KO	Coca-Cola Company (The)	Consumer Staples	CS
74	KR	Kroger Co.	Consumer Staples	CS
75	MDLZ	Mondelez International	Consumer Staples	CS
76	MKC	McCormick & Co.	Consumer Staples	CS
77	MNST	Monster Beverage	Consumer Staples	CS
78	MO	Altria Group Inc	Consumer Staples	CS
79	PEP	PepsiCo Inc.	Consumer Staples	CS
80	PG	Procter & Gamble	Consumer Staples	CS
81	SJM	JM Smucker	Consumer Staples	CS
82	STZ	Constellation Brands	Consumer Staples	CS
83	SYY	Sysco Corp.	Consumer Staples	CS
84	TAP	Molson Coors Brewing Company	Consumer Staples	CS
85	TSN	Tyson Foods	Consumer Staples	CS
86	WBA	Walgreens Boots Alliance	Consumer Staples	CS
87	WMT	Wal-Mart Stores	Consumer Staples	CS
88	APA	Apache Corporation	Energy	EG
89	APC	Anadarko Petroleum Corp	Energy	EG
90	BHGE	Baker Hughes, a GE Company	Energy	EG
91	COG	Cabot Oil & Gas	Energy	EG
92	COP	ConocoPhillips	Energy	EG
93	CVX	Chevron Corp.	Energy	EG
94	DVN	Devon Energy Corp.	Energy	EG
95	EOG	EOG Resources	Energy	EG
96	EQT	EQT Corporation	Energy	EG
97	FTI	TechnipFMC	Energy	EG
98	HAL	Halliburton Co.	Energy	EG
99	HES	Hess Corporation	Energy	EG
100	HP	Helmerich & Payne	Energy	EG
101	MRO	Marathon Oil Corp.	Energy	EG
102	NBL	Noble Energy Inc	Energy	EG
103	NOV	National Oilwell Varco Inc.	Energy	EG
104	PXD	Pioneer Natural Resources	Energy	EG

S.No.	Code	Company Name	Sector	Abbrv
105	RRC	Range Resources Corp.	Energy	EG
106	SLB	Schlumberger Ltd.	Energy	EG
107	VLO	Valero Energy	Energy	EG
108	WMB	Williams Cos.	Energy	EG
109	XEC	Cimarex Energy	Energy	EG
110	XOM	Exxon Mobil Corp.	Energy	EG
111	AFL	AFLAC Inc	Financials	FN
112	AIG	American International Group, Inc.	Financials	FN
113	AIZ	Assurant Inc.	Financials	FN
114	AJG	Arthur J. Gallagher & Co.	Financials	FN
115	AMG	Affiliated Managers Group Inc	Financials	FN
116	AMP	Ameriprise Financial	Financials	FN
117	AON	Aon plc	Financials	FN
118	AXP	American Express Co	Financials	FN
119	BAC	Bank of America Corp	Financials	FN
120	BBT	BB&T Corporation	Financials	FN
121	BEN	Franklin Resources	Financials	FN
122	BK	The Bank of New York Mellon Corp.	Financials	FN
123	BLK	BlackRock	Financials	FN
124	C	Citigroup Inc.	Financials	FN
125	CINF	Cincinnati Financial	Financials	FN
126	CMA	Comerica Inc.	Financials	FN
127	CME	CME Group Inc.	Financials	FN
128	ETFC	E*Trade	Financials	FN
129	FITB	Fifth Third Bancorp	Financials	FN
130	GS	Goldman Sachs Group	Financials	FN
131	HBAN	Huntington Bancshares	Financials	FN
132	HRB	Block H&R	Financials	FN
133	ICE	Intercontinental Exchange	Financials	FN
134	IVZ	Invesco Ltd.	Financials	FN
135	JPM	JPMorgan Chase & Co.	Financials	FN
136	KEY	KeyCorp	Financials	FN
137	L	Loews Corp.	Financials	FN
138	LNC	Lincoln National	Financials	FN
139	MCO	Moody's Corp	Financials	FN
140	MET	MetLife Inc.	Financials	FN
141	MMC	Marsh & McLennan	Financials	FN
142	MS	Morgan Stanley	Financials	FN
143	MTB	M&T Bank Corp.	Financials	FN
144	NDAQ	Nasdaq, Inc.	Financials	FN
145	NTRS	Northern Trust Corp.	Financials	FN
146	PBCT	People's United Financial	Financials	FN
147	PFG	Principal Financial Group	Financials	FN
148	PGR	Progressive Corp.	Financials	FN
149	PNC	PNC Financial Services	Financials	FN
150	PRU	Prudential Financial	Financials	FN
151	RE	Everest Re Group Ltd.	Financials	FN
152	RF	Regions Financial Corp.	Financials	FN
153	RJF	Raymond James Financial Inc.	Financials	FN
154	SCHW	Charles Schwab Corporation	Financials	FN
155	SIVB	SVB Financial	Financials	FN
156	SPGI	S&P Global, Inc.	Financials	FN

S.No.	Code	Company Name	Sector	Abbrv
157	STI	SunTrust Banks	Financials	FN
158	STT	State Street Corp.	Financials	FN
159	TMK	Torchmark Corp.	Financials	FN
160	TROW	T. Rowe Price Group	Financials	FN
161	TRV	The Travelers Companies Inc.	Financials	FN
162	UNM	Unum Group	Financials	FN
163	USB	U.S. Bancorp	Financials	FN
164	WFC	Wells Fargo	Financials	FN
165	WLTW	Willis Towers Watson	Financials	FN
166	ZION	Zions Bancorp	Financials	FN
167	A	Agilent Technologies Inc	Health Care	HC
168	ABC	AmerisourceBergen Corp	Health Care	HC
169	ABT	Abbott Laboratories	Health Care	HC
170	AGN	Allergan, Plc	Health Care	HC
171	ALGN	Align Technology	Health Care	HC
172	ALXN	Alexion Pharmaceuticals	Health Care	HC
173	AMGN	Amgen Inc.	Health Care	HC
174	ANTM	Anthem Inc.	Health Care	HC
175	BAX	Baxter International Inc.	Health Care	HC
176	BDX	Becton Dickinson	Health Care	HC
177	BIIB	Biogen Inc.	Health Care	HC
178	BMY	Bristol-Myers Squibb	Health Care	HC
179	BSX	Boston Scientific	Health Care	HC
180	CELG	Celgene Corp.	Health Care	HC
181	CERN	Cerner	Health Care	HC
182	CI	CIGNA Corp.	Health Care	HC
183	CNC	Centene Corporation	Health Care	HC
184	COO	The Cooper Companies	Health Care	HC
185	DVA	DaVita Inc.	Health Care	HC
186	EW	Edwards Lifesciences	Health Care	HC
187	GILD	Gilead Sciences	Health Care	HC
188	HOLX	Hologic	Health Care	HC
189	HSIC	Henry Schein	Health Care	HC
190	HUM	Humana Inc.	Health Care	HC
191	IDXX	IDEXX Laboratories	Health Care	HC
192	ILMN	Illumina Inc	Health Care	HC
193	INCY	Incyte	Health Care	HC
194	ISRG	Intuitive Surgical Inc.	Health Care	HC
195	LH	Laboratory Corp. of America Holding	Health Care	HC
196	LLY	Lilly (Eli) & Co.	Health Care	HC
197	MDT	Medtronic plc	Health Care	HC
198	MRK	Merck & Co.	Health Care	HC
199	MTD	Mettler Toledo	Health Care	HC
200	MYL	Mylan N.V.	Health Care	HC
201	PFE	Pfizer Inc.	Health Care	HC
202	PKI	PerkinElmer	Health Care	HC
203	PRGO	Perrigo	Health Care	HC
204	REGN	Regeneron	Health Care	HC
205	RMD	ResMed	Health Care	HC
206	SYK	Stryker Corp.	Health Care	HC
207	TMO	Thermo Fisher Scientific	Health Care	HC
208	UHS	Universal Health Services, Inc.	Health Care	HC

S.No.	Code	Company Name	Sector	Abbrv
209	UNH	United Health Group Inc.	Health Care	HC
210	VRTX	Vertex Pharmaceuticals Inc	Health Care	HC
211	WAT	Waters Corporation	Health Care	HC
212	XRAY	Dentsply Sirona	Health Care	HC
213	ZBH	Zimmer Biomet Holdings	Health Care	HC
214	AAL	American Airlines Group	Industrials	ID
215	ALK	Alaska Air Group Inc	Industrials	ID
216	AME	AMETEK Inc.	Industrials	ID
217	AOS	A.O. Smith Corp	Industrials	ID
218	ARNC	Arconic Inc.	Industrials	ID
219	AYI	Acuity Brands Inc	Industrials	ID
220	BA	Boeing Company	Industrials	ID
221	CAT	Caterpillar Inc.	Industrials	ID
222	CHRW	C. H. Robinson Worldwide	Industrials	ID
223	CMI	Cummins Inc.	Industrials	ID
224	CSX	CSX Corp.	Industrials	ID
225	CTAS	Cintas Corporation	Industrials	ID
226	DE	Deere & Co.	Industrials	ID
227	DOV	Dover Corp.	Industrials	ID
228	EFX	Equifax Inc.	Industrials	ID
229	EMR	Emerson Electric Company	Industrials	ID
230	ETN	Eaton Corporation	Industrials	ID
231	EXPD	Expeditors International	Industrials	ID
232	FAST	Fastenal Co	Industrials	ID
233	FDX	FedEx Corporation	Industrials	ID
234	FLR	Fluor Corp.	Industrials	ID
235	FLS	Flowserve Corporation	Industrials	ID
236	GD	General Dynamics	Industrials	ID
237	GE	General Electric	Industrials	ID
238	GWW	Grainger (W.W.) Inc.	Industrials	ID
239	IR	Ingersoll-Rand PLC	Industrials	ID
240	ITW	Illinois Tool Works	Industrials	ID
241	JBHT	J. B. Hunt Transport Services	Industrials	ID
242	JCI	Johnson Controls International	Industrials	ID
243	JEC	Jacobs Engineering Group	Industrials	ID
244	KSU	Kansas City Southern	Industrials	ID
245	LLL	L-3 Communications Holdings	Industrials	ID
246	LMT	Lockheed Martin Corp.	Industrials	ID
247	LUV	Southwest Airlines	Industrials	ID
248	MAS	Masco Corp.	Industrials	ID
249	NOC	Northrop Grumman Corp.	Industrials	ID
250	NSC	Norfolk Southern Corp.	Industrials	ID
251	PCAR	PACCAR Inc.	Industrials	ID
252	PH	Parker-Hannifin	Industrials	ID
253	PNR	Pentair Ltd.	Industrials	ID
254	PWR	Quanta Services Inc.	Industrials	ID
255	RHI	Robert Half International	Industrials	ID
256	ROK	Rockwell Automation Inc.	Industrials	ID
257	ROP	Roper Technologies	Industrials	ID
258	RSG	Republic Services Inc	Industrials	ID
259	RTN	Raytheon Co.	Industrials	ID
260	SRCL	Stericycle Inc	Industrials	ID
261	TXT	Textron Inc.	Industrials	ID

S.No.	Code	Company Name	Sector	Abbrv
262	UNP	Union Pacific	Industrials	ID
263	UPS	United Parcel Service	Industrials	ID
264	URI	United Rentals, Inc.	Industrials	ID
265	UTX	United Technologies	Industrials	ID
266	WM	Waste Management Inc.	Industrials	ID
267	AAPL	Apple Inc.	Information Technology	IT
268	ACN	Accenture plc	Information Technology	IT
269	ADBE	Adobe Systems Inc	Information Technology	IT
270	ADI	Analog Devices, Inc.	Information Technology	IT
271	ADP	Automatic Data Processing	Information Technology	IT
272	ADS	Alliance Data Systems	Information Technology	IT
273	ADSK	Autodesk Inc.	Information Technology	IT
274	AKAM	Akamai Technologies Inc	Information Technology	IT
275	AMAT	Applied Materials Inc.	Information Technology	IT
276	AMD	Advanced Micro Devices Inc	Information Technology	IT
277	ANSS	ANSYS	Information Technology	IT
278	APH	Amphenol Corp	Information Technology	IT
279	ATVI	Activision Blizzard	Information Technology	IT
280	CDNS	Cadence Design Systems	Information Technology	IT
281	CRM	Salesforce.com	Information Technology	IT
282	CSCO	Cisco Systems	Information Technology	IT
283	CTSH	Cognizant Technology Solutions	Information Technology	IT
284	CTXS	Citrix Systems	Information Technology	IT
285	DXC	DXC Technology	Information Technology	IT
286	EA	Electronic Arts	Information Technology	IT
287	EBAY	eBay Inc.	Information Technology	IT
288	FFIV	F5 Networks	Information Technology	IT
289	FIS	Fidelity National Information Services	Information Technology	IT
290	FISV	Fiserv Inc	Information Technology	IT
291	FLIR	FLIR Systems	Information Technology	IT
292	GLW	Corning Inc.	Information Technology	IT
293	GOOG	Alphabet Inc Class C	Information Technology	IT
294	GOOGL	Alphabet Inc Class A	Information Technology	IT
295	GPN	Global Payments Inc.	Information Technology	IT
296	HPQ	HP Inc.	Information Technology	IT
297	HRS	Harris Corporation	Information Technology	IT
298	IBM	International Business Machines	Information Technology	IT
299	INTC	Intel Corp.	Information Technology	IT
300	INTU	Intuit Inc.	Information Technology	IT
301	IT	Gartner Inc	Information Technology	IT
302	JNPR	Juniper Networks	Information Technology	IT
303	KLAC	KLA-Tencor Corp.	Information Technology	IT
304	LRCX	Lam Research	Information Technology	IT
305	MCHP	Microchip Technology	Information Technology	IT
306	MSFT	Microsoft Corp.	Information Technology	IT
307	MSI	Motorola Solutions Inc.	Information Technology	IT
308	MU	Micron Technology	Information Technology	IT
309	NFLX	Netflix Inc.	Information Technology	IT
310	NTAP	NetApp	Information Technology	IT
311	NVDA	Nvidia Corporation	Information Technology	IT
312	ORCL	Oracle Corp.	Information Technology	IT
313	PAYX	Paychex Inc.	Information Technology	IT
314	QCOM	QUALCOMM Inc.	Information Technology	IT

S.No.	Code	Company Name	Sector	Abbrv
315	RHT	Red Hat Inc.	Information Technology	IT
316	SNPS	Synopsys Inc.	Information Technology	IT
317	STX	Seagate Technology	Information Technology	IT
318	SWKS	Skyworks Solutions	Information Technology	IT
319	SYMC	Symantec Corp.	Information Technology	IT
320	TSS	Total System Services	Information Technology	IT
321	TTWO	Take-Two Interactive	Information Technology	IT
322	TXN	Texas Instruments	Information Technology	IT
323	VRSN	Verisign Inc.	Information Technology	IT
324	WDC	Western Digital	Information Technology	IT
325	XLNX	Xilinx Inc	Information Technology	IT
326	APD	Air Products & Chemicals Inc	Materials	MT
327	AVY	Avery Dennison Corp	Materials	MT
328	BLL	Ball Corp	Materials	MT
329	CF	CF Industries Holdings Inc	Materials	MT
330	DWDP	DowDuPont	Materials	MT
331	ECL	Ecolab Inc.	Materials	MT
332	FCX	Freeport-McMoRan Inc.	Materials	MT
333	FMC	FMC Corporation	Materials	MT
334	IFF	Intl Flavors & Fragrances	Materials	MT
335	IP	International Paper	Materials	MT
336	MOS	The Mosaic Company	Materials	MT
337	NEM	Newmont Mining Corporation	Materials	MT
338	NUE	Nucor Corp.	Materials	MT
339	PKG	Packaging Corporation of America	Materials	MT
340	SEE	Sealed Air	Materials	MT
341	SHW	Sherwin-Williams	Materials	MT
342	CTL	CenturyLink Inc	Telecommunication Services	TC
343	T	AT&T Inc.	Telecommunication Services	TC
344	VZ	Verizon Communications	Telecommunication Services	TC
345	AEE	Ameren Corp	Utilities	UT
346	AEP	American Electric Power	Utilities	UT
347	AES	AES Corp	Utilities	UT
348	CMS	CMS Energy	Utilities	UT
349	CNP	CenterPoint Energy	Utilities	UT
350	D	Dominion Energy	Utilities	UT
351	DTE	DTE Energy Co.	Utilities	UT
352	DUK	Duke Energy	Utilities	UT
353	ED	Consolidated Edison	Utilities	UT
354	EIX	Edison Int'l	Utilities	UT
355	ES	Eversource Energy	Utilities	UT
356	ETR	Entergy Corp.	Utilities	UT
357	EXC	Exelon Corp.	Utilities	UT
358	FE	FirstEnergy Corp	Utilities	UT
359	LNT	Alliant Energy Corp	Utilities	UT
360	NEE	NextEra Energy	Utilities	UT
361	NI	NiSource Inc.	Utilities	UT
362	NRG	NRG Energy	Utilities	UT
363	PCG	PG&E Corp.	Utilities	UT
364	PEG	Public Serv. Enterprise Inc.	Utilities	UT

S.No.	Code	Company Name	Sector	Abbrv
365	SO	Southern Co.	Utilities	UT
366	SRE	Sempra Energy	Utilities	UT
367	WEC	Wec Energy Group Inc	Utilities	UT
368	XEL	Xcel Energy Inc	Utilities	UT

Table S6. List of 173 stocks of JPN Nikkei 225 considered for the analysis present over the period of 2006-2018.

S.No.	Code	Company Name	Sector	Abbrv
1	1332.T	NIPPON SUISAN KAISHA, LTD.	Consumer Goods	CG
2	2002.T	NISSHIN SEIFUN GROUP INC.	Consumer Goods	CG
3	2282.T	NH FOODS LTD.	Consumer Goods	CG
4	2501.T	SAPPORO HOLDINGS LTD.	Consumer Goods	CG
5	2502.T	ASAHI GROUP HOLDINGS, LTD.	Consumer Goods	CG
6	2503.T	KIRIN HOLDINGS CO., LTD.	Consumer Goods	CG
7	2531.T	TAKARA HOLDINGS INC.	Consumer Goods	CG
8	2801.T	KIKKOMAN CORP.	Consumer Goods	CG
9	2802.T	AJINOMOTO CO., INC.	Consumer Goods	CG
10	2871.T	NICHIREI CORP.	Consumer Goods	CG
11	3086.T	J.FRONT RETAILING CO., LTD.	Consumer Goods	CG
12	3099.T	ISETAN MITSUKOSHI HOLDINGS LTD.	Consumer Goods	CG
13	3382.T	SEVEN & I HOLDINGS CO., LTD.	Consumer Goods	CG
14	4324.T	DENTSU INC.	Consumer Goods	CG
15	4704.T	TREND MICRO INC.	Consumer Goods	CG
16	8028.T	FAMILYMART UNY HOLDINGS CO., LTD.	Consumer Goods	CG
17	8233.T	TAKASHIMAYA CO., LTD.	Consumer Goods	CG
18	8252.T	MARUI GROUP CO., LTD.	Consumer Goods	CG
19	8267.T	AEON CO., LTD.	Consumer Goods	CG
20	9602.T	TOHO CO., LTD	Consumer Goods	CG
21	9681.T	TOKYO DOME CORP.	Consumer Goods	CG
22	9735.T	SECOM CO., LTD.	Consumer Goods	CG
23	9766.T	KONAMI HOLDINGS CORP.	Consumer Goods	CG
24	9983.T	FAST RETAILING CO., LTD.	Consumer Goods	CG
25	1721.T	COMSYS HOLDINGS CORP.	Capital Goods/Others	CP
26	1801.T	TAISEI CORP.	Capital Goods/Others	CP
27	1802.T	OBAYASHI CORP.	Capital Goods/Others	CP
28	1803.T	SHIMIZU CORP.	Capital Goods/Others	CP
29	1808.T	HASEKO CORP.	Capital Goods/Others	CP
30	1812.T	KAJIMA CORP.	Capital Goods/Others	CP
31	1928.T	SEKISUI HOUSE, LTD.	Capital Goods/Others	CP
32	1963.T	JGC CORP.	Capital Goods/Others	CP
33	5631.T	THE JAPAN STEEL WORKS, LTD.	Capital Goods/Others	CP
34	6113.T	AMADA HOLDINGS CO., LTD.	Capital Goods/Others	CP
35	6301.T	KOMATSU LTD.	Capital Goods/Others	CP
36	6302.T	SUMITOMO HEAVY IND., LTD.	Capital Goods/Others	CP
37	6305.T	HITACHI CONST. MACH. CO., LTD.	Capital Goods/Others	CP
38	6326.T	KUBOTA CORP.	Capital Goods/Others	CP
39	6361.T	EBARA CORP.	Capital Goods/Others	CP
40	6366.T	CHIYODA CORP.	Capital Goods/Others	CP
41	6367.T	DAIKIN INDUSTRIES, LTD.	Capital Goods/Others	CP
42	6471.T	NSK LTD.	Capital Goods/Others	CP
43	6472.T	NTN CORP.	Capital Goods/Others	CP
44	6473.T	JTEKT CORP.	Capital Goods/Others	CP
45	7003.T	MITSUI E&S HOLDINGS CO., LTD.	Capital Goods/Others	CP

S.No.	Code	Company Name	Sector	Abbrv
46	7004.T	HITACHI ZOSEN CORP.	Capital Goods/Others	CP
47	7011.T	MITSUBISHI HEAVY IND., LTD.	Capital Goods/Others	CP
48	7012.T	KAWASAKI HEAVY IND., LTD.	Capital Goods/Others	CP
49	7013.T	IHI CORP.	Capital Goods/Others	CP
50	7911.T	TOPPAN PRINTING CO., LTD.	Capital Goods/Others	CP
51	7912.T	DAI NIPPON PRINTING CO., LTD.	Capital Goods/Others	CP
52	7951.T	YAMAHA CORP.	Capital Goods/Others	CP
53	8801.T	MITSUI FUDOSAN CO., LTD.	Capital Goods/Others	CP
54	8802.T	MITSUBISHI ESTATE CO., LTD.	Capital Goods/Others	CP
55	8804.T	TOKYO TATEMONO CO., LTD.	Capital Goods/Others	CP
56	8830.T	SUMITOMO REALTY & DEVELOPMENT CO., LTD.	Capital Goods/Others	CP
57	8253.T	CREDIT SAISON CO., LTD.	Financials	FN
58	8303.T	SHINSEI BANK, LTD.	Financials	FN
59	8331.T	THE CHIBA BANK, LTD.	Financials	FN
60	8355.T	THE SHIZUOKA BANK, LTD.	Financials	FN
61	8601.T	DAIWA SECURITIES GROUP INC.	Financials	FN
62	8604.T	NOMURA HOLDINGS, INC.	Financials	FN
63	8628.T	MATSUI SECURITIES CO., LTD.	Financials	FN
64	2768.T	SOJITZ CORP.	Materials	MT
65	3101.T	TOYOBO CO., LTD.	Materials	MT
66	3103.T	UNITIKA, LTD.	Materials	MT
67	3401.T	TEIJIN LTD.	Materials	MT
68	3402.T	TORAY INDUSTRIES, INC.	Materials	MT
69	3405.T	KURARAY CO., LTD.	Materials	MT
70	3407.T	ASAHI KASEI CORP.	Materials	MT
71	3436.T	SUMCO CORP.	Materials	MT
72	3861.T	OJI HOLDINGS CORP.	Materials	MT
73	4004.T	SHOWA DENKO K.K.	Materials	MT
74	4005.T	SUMITOMO CHEMICAL CO., LTD.	Materials	MT
75	4042.T	TOSOH CORP.	Materials	MT
76	4043.T	TOKUYAMA CORP.	Materials	MT
77	4061.T	DENKA CO., LTD.	Materials	MT
78	4063.T	SHIN-ETSU CHEMICAL CO., LTD.	Materials	MT
79	4183.T	MITSUI CHEMICALS, INC.	Materials	MT
80	4188.T	MITSUBISHI CHEMICAL HOLDINGS CORP.	Materials	MT
81	4208.T	UBE INDUSTRIES, LTD.	Materials	MT
82	4272.T	NIPPON KAYAKU CO., LTD.	Materials	MT
83	4452.T	KAO CORP.	Materials	MT
84	4631.T	DIC CORP.	Materials	MT
85	4901.T	FUJIFILM HOLDINGS CORP.	Materials	MT
86	4911.T	SHISEIDO CO., LTD.	Materials	MT
87	5020.T	JXTG HOLDINGS, INC.	Materials	MT
88	5101.T	THE YOKOHAMA RUBBER CO., LTD.	Materials	MT
89	5108.T	BRIDGESTONE CORP.	Materials	MT
90	5201.T	AGC INC.	Materials	MT
91	5202.T	NIPPON SHEET GLASS CO., LTD.	Materials	MT
92	5232.T	SUMITOMO OSAKA CEMENT CO., LTD.	Materials	MT
93	5233.T	TAIHEIYO CEMENT CORP.	Materials	MT
94	5301.T	TOKAI CARBON CO., LTD.	Materials	MT
95	5333.T	NGK INSULATORS, LTD.	Materials	MT

S.No.	Code	Company Name	Sector	Abbrv
96	5401.T	NIPPON STEEL CORP.	Materials	MT
97	5406.T	KOBE STEEL, LTD.	Materials	MT
98	5411.T	JFE HOLDINGS, INC.	Materials	MT
99	5541.T	PACIFIC METALS CO., LTD.	Materials	MT
100	5703.T	NIPPON LIGHT METAL HOLDINGS CO., LTD.	Materials	MT
101	5706.T	MITSUI MINING & SMELTING CO.	Materials	MT
102	5707.T	TOHO ZINC CO., LTD.	Materials	MT
103	5711.T	MITSUBISHI MATERIALS CORP.	Materials	MT
104	5713.T	SUMITOMO METAL MINING CO., LTD.	Materials	MT
105	5714.T	DOWA HOLDINGS CO., LTD.	Materials	MT
106	5801.T	FURUKAWA ELECTRIC CO., LTD.	Materials	MT
107	5802.T	SUMITOMO ELECTRIC IND., LTD.	Materials	MT
108	5803.T	FUJIKURA LTD.	Materials	MT
109	5901.T	TOYO SEIKAN GROUP HOLDINGS, LTD.	Materials	MT
110	6988.T	NITTO DENKO CORP.	Materials	MT
111	8001.T	ITOCHU CORP.	Materials	MT
112	8002.T	MARUBENI CORP.	Materials	MT
113	8015.T	TOYOTA TSUSHO CORP.	Materials	MT
114	8031.T	MITSUI & CO., LTD.	Materials	MT
115	8053.T	SUMITOMO CORP.	Materials	MT
116	8058.T	MITSUBISHI CORP.	Materials	MT
117	3105.T	NISSHINBO HOLDINGS INC.	Technology	TC
118	4151.T	KYOWA KIRIN CO., LTD.	Technology	TC
119	4502.T	TAKEDA PHARMACEUTICAL CO., LTD.	Technology	TC
120	4503.T	ASTELLAS PHARMA INC.	Technology	TC
121	4506.T	SUMITOMO DAINIPPON PHARMA CO., LTD.	Technology	TC
122	4507.T	SHIONOGI & CO., LTD.	Technology	TC
123	4519.T	CHUGAI PHARMACEUTICAL CO., LTD.	Technology	TC
124	4523.T	EISAI CO., LTD.	Technology	TC
125	4543.T	TERUMO CORP.	Technology	TC
126	4902.T	KONICA MINOLTA, INC.	Technology	TC
127	6479.T	MINEBEA MITSUMI INC.	Technology	TC
128	6501.T	HITACHI, LTD.	Technology	TC
129	6503.T	MITSUBISHI ELECTRIC CORP.	Technology	TC
130	6504.T	FUJI ELECTRIC CO., LTD.	Technology	TC
131	6506.T	YASKAWA ELECTRIC CORP.	Technology	TC
132	6645.T	OMRON CORP.	Technology	TC
133	6674.T	GS YUASA CORP.	Technology	TC
134	6701.T	NEC CORP.	Technology	TC
135	6703.T	OKI ELECTRIC IND. CO., LTD.	Technology	TC
136	6724.T	SEIKO EPSON CORP.	Technology	TC
137	6758.T	SONY CORP.	Technology	TC
138	6762.T	TDK CORP.	Technology	TC
139	6770.T	ALPS ALPINE CO., LTD.	Technology	TC
140	6841.T	YOKOGAWA ELECTRIC CORP.	Technology	TC
141	6902.T	DENSO CORP.	Technology	TC
142	6952.T	CASIO COMPUTER CO., LTD.	Technology	TC
143	6954.T	FANUC CORP.	Technology	TC
144	7201.T	NISSAN MOTOR CO., LTD.	Technology	TC
145	7202.T	ISUZU MOTORS LTD.	Technology	TC
146	7203.T	TOYOTA MOTOR CORP.	Technology	TC
147	7205.T	HINO MOTORS, LTD.	Technology	TC
148	7211.T	MITSUBISHI MOTORS CORP.	Technology	TC

S.No.	Code	Company Name	Sector	Abbrv
149	7261.T	MAZDA MOTOR CORP.	Technology	TC
150	7269.T	SUZUKI MOTOR CORP.	Technology	TC
151	7270.T	SUBARU CORP.	Technology	TC
152	7272.T	YAMAHA MOTOR CO., LTD.	Technology	TC
153	7731.T	NIKON CORP.	Technology	TC
154	7735.T	SCREEN HOLDINGS CO., LTD.	Technology	TC
155	7752.T	RICOH CO., LTD.	Technology	TC
156	8035.T	TOKYO ELECTRON LTD.	Technology	TC
157	9412.T	SKY PERFECT JSAT HOLDINGS INC.	Technology	TC
158	9984.T	SOFTBANK GROUP CORP.	Technology	TC
159	9001.T	TOBU RAILWAY CO., LTD.	Transportation and Utilities	UT
160	9005.T	TOKYU CORP.	Transportation and Utilities	UT
161	9007.T	ODAKYU ELECTRIC RAILWAY CO., LTD.	Transportation and Utilities	UT
162	9008.T	KEIO CORP.	Transportation and Utilities	UT
163	9009.T	KEISEI ELECTRIC RAILWAY CO., LTD.	Transportation and Utilities	UT
164	9062.T	NIPPON EXPRESS CO., LTD.	Transportation and Utilities	UT
165	9064.T	YAMATO HOLDINGS CO., LTD.	Transportation and Utilities	UT
166	9101.T	NIPPON YUSEN K.K.	Transportation and Utilities	UT
167	9104.T	MITSUI O.S.K.LINES, LTD.	Transportation and Utilities	UT
168	9107.T	KAWASAKI KISEN KAISHA, LTD.	Transportation and Utilities	UT
169	9301.T	MITSUBISHI LOGISTICS CORP.	Transportation and Utilities	UT
170	9501.T	TOKYO ELECTRIC POWER COMPANY HOLD-INGS, I	Transportation and Utilities	UT
171	9502.T	CHUBU ELECTRIC POWER CO., INC.	Transportation and Utilities	UT
172	9503.T	THE KANSAI ELECTRIC POWER CO., INC.	Transportation and Utilities	UT
173	9532.T	OSAKA GAS CO., LTD.	Transportation and Utilities	UT