استخدام شجرة الامتداد الدنيا لتحليل عمل المصارف العراقية في سوق العراق للأوراق المالية

م.م بيداء صالح مهدي
مديرية تربية الكرخ الثانية
baidaasaleh78@gmail.com

الملخص:
سيؤثر تحليل سوق العراق للأوراق المالية وفهم سلوكه إيجابًا على الاستثمار في العراق. لذلك، تمت دراسة نموذج شبكة شركات القطاع المصرفي في سوق العراق للأوراق المالية على شكل رسم بياني مرجح كامل. باستخدام أدوات نظرية الرسم البياني، تتوافق رؤوس هذا الرسم البياني مع الشركات المتعثرة، ويتم تحديد أوزان الحواف من خلال المسافة فوق المعيارية لشجرة الامتداد الدنيا. تم رسم الإطار التشغيلي للمصارف من خلال إنشاء شجرة امتدادية دنيا باستخدام طريقة كروسكال.

الكلمات المفتاحية: نظرية الرسم البياني، شجرة الامتداد الدنيا، سوق العراق للأوراق المالية، خوارزمية كروسكال، نموذج الشبكة

Using the minimum spanning tree to analyze the work of Iraqi banks within the Iraqi Stock Exchange

Baidaa Saleh Mahdi
Baghdad Education Directorate / Al-Karkh 2
baidaasaleh78@gmail.com

Abstract
Analyzing the Iraqi Stock Exchange and understanding its behavior will have a positive impact on investment in Iraq. Therefore, the network model of the banking sector companies within the Iraqi Stock Exchange was studied in the form of a complete weighted graph. Use graph theory tools. The vertices of this graph correspond to sink firms, and the weights of the edges are determined by the supra-standard distance of the minimum spanning tree. The operational framework of sinks was mapped out by constructing a minimum spanning tree employing Kruskal's method.
Keywords: Graph theory, Minimum spanning tree, Iraqi stock market, Kruskal's algorithm, Network model.

1- Introduction:

As it is known to everyone, studying the Iraqi stock markets, as revitalizing and developing the stock market is considered one of the basic matters that will help achieve economic and financial development in Iraq, as it will provide investors with greater opportunities to invest in stocks and achieve greater profits in the long term. It is particularly important to study the correlational effect of the number of Iraqi banks that actually operate within the Iraqi Stock Exchange using

graph theory, which was known in 1736 when it was established by Euler (1) and Kant. Koenig (2) views it as a subdivision of mathematics, subsequently evolving into a favored and significant instrument across diverse fields including biology, mathematics, computer science, sociology, transportation, communication networks, finance, and more (1, 2).

Lately, there's been a growing trend of utilizing networks for the programming and simulation of global stock markets. The fundamental concept underpinning these networks involves a connection between two distinct elements. Mantegna is credited as the pioneer who first visualized these elements as vertices within graph theory, employing the Pearson correlation coefficient (3) for this purpose., while studies conducted by Bonanno et al., 2003 (4) and Micic et al., 2003 showed The application of Minimum Spanning Trees (MST) for investigating the connection between equity valuations and spanning tree structures (employing the smallest possible span) and examining their correlation.Xu et al., 2002, reported a completely new scheme for a multidimensional gene expression data set such as MST (5). But March et al. 2010 (6), An MST was devised to enable rapid processing of extensive astronomical datasets, encompassing millions of nodes and terabytes of data storage (which we'll denote as '6' based on the original).. Conversely, Sheng and colleagues in 2017 utilized Minimum Spanning Trees (MST) to enhance the estimation of entropy and divergence for random variables laden with uncertainty (7). Furthermore, Akpan and Iwok, writing in 2017 (8), used MST to solve and reduce the transportation hurdle cost in cable charging, which is required for underground site cable installation (8). While Ahmed et al., 2019 (9The minimum spanning tree algorithm was employed for identifying abnormal data points present within the gathered information, a technique that is regarded as an enhancement to detection efficacy (9).. Luo et al., 2020 (10) A hybrid feature extraction method for motor imagery EEG signal classification was developed, employing a Minimum Spanning Tree built upon the ground-truth nodes of the motor imagery EEG signals (10).

This relationship was applied in research conducted previously in analyzing the structure of the stock market in Iraq for a number of different sectors within the market. It was applied a second time to the number of infections with the Corona virus within Middle Eastern countries and a third to the number of the same infections for the governorates of Iraq. This is our fourth application on the basis of the minimum tree. Extended, (similar to a study conducted by Abbassian-Naghna et al., 2020 (11)) that dealt with the analysis of the Iraqi stock market network for various sectors, and is considered the first research study in this field

using graph theory tools. One method that is mathematically defined as subgraphs that connect and connect all nodes formed in the network with the least weights and without cycle is the minimum spanning tree (12, 13, 14). The importance and utility of the Minimum Spanning Tree (MST) are rooted in its capacity to efficiently locate and underpin a resolution for extensive graph structures, possessing the scalability to manage graphs featuring thousands of nodes (15).

The current research focuses on how the number of monthly closures for each bank affects the market, as well as to find out which bank is the center of the rest of the other banks.

2- Materials and methods

Banks operating within the Iraq Stock Exchange were selected, and monthly closings were taken for a full year from January 2023 to September 2023. Data were collected from the annual report of the Iraq Stock Exchange for the year 2023, as these banks represented the entities within the network. Statement theory was used to analyze the network, A square matrix was initially established through the calculation of the correlation coefficient. Subsequently, this matrix underwent transformation into a distance matrix. Following this, a graph was generated to visually depict the values contained within the distance matrix, employing Kruskal's algorithm and a Python script to determine the Minimum Spanning Tree (MTS) within the network. Finally, the Microsoft Excel program was utilized for the representation and visualization of this resulting MTS.

3-Methodology and network construction

This section focuses on dissecting a modest network comprising fourteen Iraqi banks engaged in market operations, one of which is the Islamic Spectrum Bank (BTIB).Al-Eqtisad Bank for Investment (BEFI), the Credit Bank of Iraq (BROI), Al-Mansour Bank (BMNS), Mosul Bank for Investment (BMFI), and Gulf Bank (BGUC), the Bank of Babylon (BBAY), the Commercial Bank of Sumer (BSUC), the National Bank of Iraq (BNOI), the Investment Bank of Iraq (BIBI), the Bank of the Middle East (BIME), the Islamic Iraqi Bank (BIIB), the Bank of Baghdad (BBOB), and the Commercial Bank (BCOI), where they were chosen. 14 banks randomly from among 43 banks officially registered in the market for a full year from January to September 2023. The correlation matrix was found using the correlation coefficient between each two banks using the monthly closings for each bank using formula (1) below:

$$R_{xy} = \frac{\mathbf{COV(X,Y)}}{\boldsymbol{R_x R_y}} = \frac{\boldsymbol{E((X-MX)(Y-MY))}}{\boldsymbol{R_x R_y}} \quad \ldots (1)$$

COV(X,Y) it means the covariance or variables between two random variables x and y, and it can be written in another from E ((X-MX)(Y-MY)).

Then we get the following square correlation matrix .

Table 1. Correlation matrix for the 12-month period January 2023/December 2023

	BTIB	BEFI	BROI	BMNS	BMFI	BGUC	BBAY	BSUC	BNOI	BIBI	BIME	BIIB	BBOB	BCOI
BTIB	1	0.047	0.0149	0.0365	0.2141	0.0741	-0.339	0.0223	0.0098	-0.038	0.3372	-0.096	-0.059	0.0098
BEFI	0.047	1	0.902	0.6664	0.1962	0.9511	0.6687	-0.538	0.8568	0.6175	0.1356	0.4847	0.8091	0.9439
BROI	0.0149	0.902	1	0.8863	0.545	0.8826	0.6189	-0.646	0.8936	0.6549	-0.084	0.6515	0.9041	0.9747
BMNS	0.0365	0.6664	0.8863	1	0.0497	0.5673	0.445	-0.586	0.8743	0.7221	-0.188	0.7373	0.8438	0.8384
BMFI	0.2141	0.1962	0.545	0.0497	1	0.3718	0.0978	0.4518	0.0055	0.0035	0.679	-0.216	-0.150	0.1971
BGUC	0.0741	0.9511	0.8826	0.5673	03718	1	0.7006	-0.332	0.7422	0.4607	0.3069	0.2561	-0.651	0.8852
BBAY	-0.339	0.6687	0.6189	0.445	0.0978	0.7006	1	-0.246	0.6074	0.3896	0.0676	0.2866	0.4767	0.7017
BSUC	0.0223	-0.538	-0.646	-0.586	0.4518	-0.332	-0.246	1	-0.608	-0.519	0.6359	-0.791	-0.770	-0.607
BNOI	0.0098	0.8568	0.8936	0.8743	0.0055	0.7422	0.6074	-0.608	1	0.8127	-0.136	0.7337	0.898	0.8945
BIBI	-0.038	0.6175	0.6549	0.7221	0.0035	0.4607	0.3896	-0.519	0.8127	1	-0.209	0.808	0.7018	0.6868
BIME	0.3372	0.1356	-0.084	-0.188	0.679	0.3069	0.0676	0.6359	-0.136	-0.209	1	-0.530	-0.312	-0.530
BIIB	-0.096	0.4847	0.6515	0.7373	-0.217	0.2515	0.2866	-0.791	0.7337	0.808	-0.530	1	0.706	0.6161
BBOB	-0.059	0.8091	0.9041	0.8438	-0.150	0.6515	0.4767	-0.770	0.898	0.7018	-0.312	0.706	1	0.8671
BCOI	0.0098	0.9439	0.9747	0.8384	0.1971	0.8852	0.7017	-0.607	0.8945	0.6868	0.0112	0.6161	0.8671	1

The matrix detailing correlations underwent a conversion into a distance metric. This resulting structure is square and perfectly symmetrical, featuring diagonal entries that are precisely zero, while all off-diagonal values are real numbers greater than or equal to zero, specifically within the range [2.0].. [2.0] This value is derivable through the application of formula (2), as illustrated in Table 2.

d_{xy}represents the distance function between banks x and y and is achieved using the correlation coefficient of the two banks R_{XY}

$$d_{xy} = \sqrt{2(1 - R_{xy})} \quad \dots(2)$$

Table 2: A distance matrix for the 12-month period January 2023/December 2023

	BTIB	BEFI	BROI	BMNS	BMFI	BGUC	BBAY	BSUC	BNOI	BIBI	BIME	BIIB	BBOB	BCOI
BTIB	0	1.381	1.404	1.388	1.254	1.361	1.637	1.398	1.407	1.441	1.151	1.481	1.456	1.407
BEFI	1.381	0	0.443	0.817	1.268	0.313	0.814	1.754	0.535	0.875	1.315	1.015	0.618	0.335
BROI	1.404	0.443	0	0.477	0.954	0.485	0.873	1.815	0.461	0.831	1.473	0.835	0.438	0.225
BMNS	1.388	0.817	0.477	0	1.379	0.93	1.054	1.781	0.501	0.746	1.542	0.725	0.559	0.569
BMFI	1.254	1.268	0.954	1.379	0	1.121	1.343	1.047	1.41	1.412	0.821	1.561	1.517	1.267
BGUC	1.361	0.313	0.485	0.93	1.121	0	0.774	1.632	0.718	1.039	1.177	1.22	0.835	0.479
	1.637	0.814	0.873	1.054	1.343	0.774	0	1.579	0.886	1.105	1.366	1.194	1.023	0.772
BSUC	1.398	1.754	1.815	1.781	1.047	1.632	1.579	0	1.794	1.743	0.853	1.893	1.882	1.793
BNOI	1.407	0.535	0.461	0.501	1.41	0.718	0.886	1.794	0	0.612	1.508	0.73	0.452	0.459
BIBI	1.441	0.875	0.831	0.746	1.412	1.039	1.105	1.743	0.612	0	1.555	0.62	0.772	0.792
BIME	1.151	1.315	1.473	1.542	0.821	1.177	1.366	0.853	1.508	1.555	0	1.75	1.622	1.402
BIIB	.1.481	1.015	0.835	0.725	1.561	1.22	1.194	1.893	0.73	0.62	1.75	0	0.767	0.876
BB	1.4	0.6	0.4	0.5	1.5	0.8	1.0	1.8	0.4	0.7	1.6	0.7	0	0.5

OB	56	18	38	59	17	35	23	82	52	72	2	67		16
BC	1.4	0.3	0.2	0.5	1.2	0.4	0.7	1.7	0.4	0.7	1.4	0.8	0.5	0
OI	07	35	25	69	67	79	72	93	59	92	02	76	16	

When comparing Tables 1 and 2, we find a change in the results from the period [1,-1] to [2,0]. The graph network is built using the data in Table 2, where this data represents the weight edges (meaning the distance between each vertex). We will find the MST for the Iraqi banking network using the Kruskal algorithm and with the help of the Python program. We represented the 14 sinks that we used in our study with numbers from 1 to 14. With the help of the Python program we obtained the MST as shown in Table 3 which contains 13 edges without cycles.

Table 3: The Minimum spanning tree

14	**4**	**0.225**
6	**2**	**0.313**
14	**2**	**0.335**
13	**3**	**0.438**
3	**2**	**0.443**
13	**9**	**0.452**
14	**9**	**0.459**
10	**9**	**0.612**
12	**11**	**0.621**
7	**14**	**0.772**
11	**5**	**0.821**
11	**8**	**0.853**
1	**11**	**1.151**
		7.495

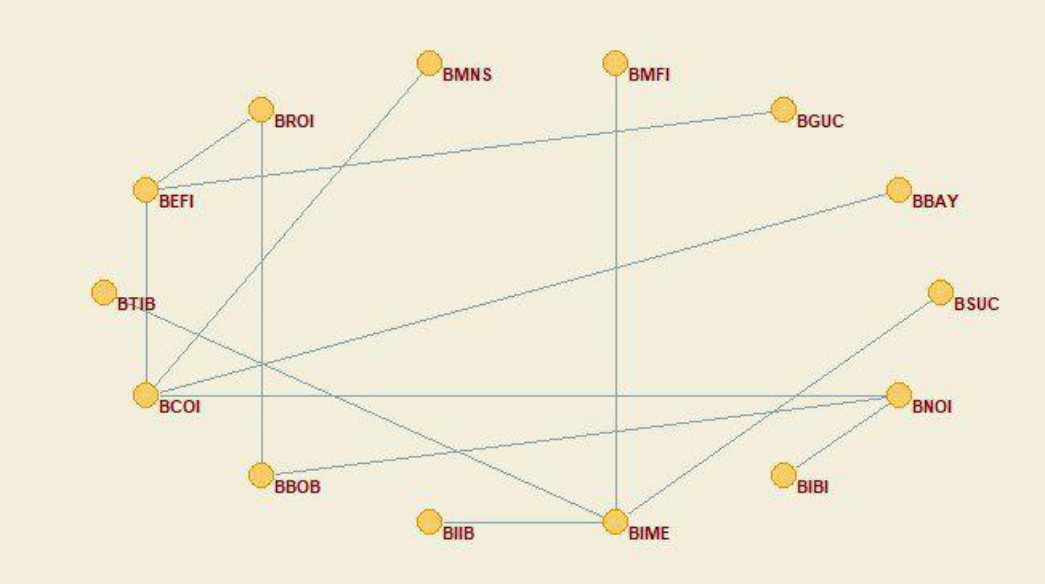
The dataset was augmented, and the Minimum Spanning Tree outcomes were categorized to adhere to Excel specifications, enabling the identification of the network file as detailed in Table (4).

Table 4: The net

14	**4**	**0.225**
6	**2**	**0.313**

14	2	0.335
13	3	0.438
3	2	0.443
13	9	0.452
14	9	0.459
10	9	0.612
12	11	0.621
7	14	0.772
11	5	0.821
11	8	0.853
1	11	1.151

Following the processing of the information presented in Tables 1 and 2 using Microsoft Excel, the subsequent visualization will be generated.



Conclusions:

An analysis of the network of Iraqi banks that actually operate within the Iraqi Stock Exchange shows that the Commercial Bank (BCOI) is the center of work for banks, occupying first place, followed by the National Bank of Iraq (BNOI), where it occupies second place, then the Bank of the Middle East (BIME) comes in third place. The fourth place comes to the Economic Bank for Investment (BEFI), and therefore these banks must receive great attention from those in charge of the market, because the more active and diversified these banks are, the more they have a positive impact on the work of other banks, and vice versa.

References

1.Euler L. The solution of a problem relating to the geometry of position. Commentarii academiae scientiarum Petropolitanae. 2018; 8: 128-140.

2.Graham EL, Hell P. On the history of minimum spanning tree. Annals of the History of Computing. 1985; 7(1): 43- 57.

3.Mantegna RN. Hierarchical structure in financial markets Statistical Mechanics. 1999; 14(29): 193- 197. DOI: 10.1007/s100510050929

4.Bonanno G, Caldarelli G, Lillo F, Mantegna RN, et al. Topology of correiation-based minimal spanning trees in real and model markets. Statistical Mechanics. 2002. DOI: 10.1103/PhysRevE.68.046130.

5.Xu Y, Olman V, Xu D. Clustering gene expression data using a graph-theoretic approach: An application of minimum spanning trees. Bioinformatics. 2002; 18(4): 536–545, 2002, doi: 10.1093/bioinformatics/18.4.536

6.March WB, Ram P, Gray AG. Fast Euclidean Minimum Spanning Tree: Algorithm, analysis, and applications. Proceeding ACM Conference on Knowledge Discovery and Data Mining. 2010; 2010: 603–611. doi: 10.1145/1835804.1835882.

7.Sheng Y, Shi G, Ralescu DA. Entropy of Uncertain Random Variables with Application to Minimum Spanning Tree Problem. International Journal of Uncertainty, Fuzziness Knowledge-Based Systems. 2017; 25(4): 497-514. https://doi.org/10.1142/S0218488517500210.

8.Akpan NP, Iwok IA. A minimum spanning tree approach of solving a transportation problem. International Journal of Mathematics and Statistics Inventions, 2017; 5(3): 9–18.

9.Ahmed I, Dagnino A, Ding Y. Unsupervised Anomaly Detection Based on Minimum Spanning Tree Approximated Distance Measures and its Application to Hydropower Turbines. IEEE Trans. Autom. Sci. Eng. 2019; 16(2): 654–667, doi: 10.1109/TASE.2018.2848198.

10.Luo Z, Lu X, Xi X. EEG Feature Extraction Based on a Bilevel Network: Minimum Spanning Tree and Regional Network. Electronics. 2020; 9(2): 203, doi: 10.3390/electronics9020203.

11.Abbasian-Naghneh S, Tehrani R, Tamimi M. 2020. The Network Analysis of Tehran Stock Exchange using Minimum Spanning Tree and Hierarchical Clustering. Iranian Journal of Finance. DOI: 10.22034/ijf.2020.193709.1042

12.Geller C, Varbanov M, Duval RE. Human coronaviruses: insights into environmental resistance and its influence on the development of new antiseptic strategies. Viruses. 2012; 4(11): 3044–3068. doi:10.3390/v4113044. PMC 3509683. PMID 23202515.

13.Kong W, Guo X, Zhao X, Vecchiato G, Babiloni F. Spectral Analysis of Brain Function Network for the Classification of Motor Imagery Tasks. INFO NR. 2011; 2011: 850–853. 10.1109/BMEI.2011.6098491

14.Zhang X, Lei X, Wu T, Jiang T. A review of EEG and MEG for brainnetome research, Cogn Neurodyn. 2014; 8: 87–98, 2014, doi: 10.1007/s11571-013-9274-9.

15.Stanley ML, Simpson SL, Dagenbach D, Lyday RG, et al. Changes in Brain Network Efficiency and Working Memory Performance in Aging. Plos One. 2015; 10(4): e0123950. doi: 10.1371/journal.pone.0123950.