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Sectoral interdependence and causal dynamics in Jordanian financial markets: Evidence from benchmark and sectoral indices

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Abstract

The study investigates the financial nexus and causal linkages among the Jordanian benchmark index (AMMAN SE General) and its five major sectoral indices, namely the Jordan Banking Index (AMBX), Industry Index (AMIDX), Mining and Extraction Industries Index (AMMEIX), Service Index (AMSX), and Utility and Energy Index (AMUEX). The daily closing values of all selected six indices are considered for the period spanning January 1, 2013, to June 30, 2024. Various advanced econometric techniques such as the Johansen Cointegration test, Vector Error Correction Model (VECM), and Granger Causality are employed to achieve the study's aim. The findings confirm both long-run equilibrium and short-run dynamics among the Jordanian benchmark and selected sectoral indices. The study results further reveal the presence of significant bidirectional and unidirectional causal relationships among the indices, with AMBX and AMMEIX emerging as pivotal drivers. The study results demonstrate that the Mining and Extraction Index and the Utility and Energy Index negatively impact AMMAN_SE. Conversely, the Banking, Industrial, and Service indices showcase positive effects on the benchmark index. The study highlights the significance of sectoral interdependence for market stability and portfolio diversification. The present study contributes to understanding Jordan's financial markets, offering insights for investors and regulators to enhance resilience and optimize strategies.

Keywords: Causal relationships, Cointegration, Financial integration, Portfolio diversification, Vector Error correction model.

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1. Introduction

Jordan is an ancient country that has strategically placed itself in the Middle East and reflects economic resilience and adaptability despite its meager natural resources. The country has managed to stabilize its economy and ensure sustainable growth in times of uncertainty in the region caused by geopolitical instability [1]. Gross domestic product of Jordan stood at USD 46.6 billion in 2022 with a growth rate of 2.7%, as per Lloyds Bank. The country's economy is primarily dominated by service sectors, accounting for nearly 60% of the gross domestic product. These include some critical areas such as tourism, financial services, education, and health care sectors. Jordan has been geographically positioned as a regional trade and logistics hub in regional connectivity and international cooperation [2]. These economic characteristics make Jordan an interesting case for any study on financial interdependence, especially through its stock exchange and main economic sectors.

The Amman Stock Exchange, which was established in the year 1978, provides Jordan's financial structure; hence, it has become an essential cornerstone of the country's economic framework over time. The ASE plays a significant role in fostering transparency and promoting capital market development, portraying Jordan's overall economic health [3]. The Jordan Benchmark Index (AMMAN SE General) reflects the aggregate market performance and acts as a leading indicator of Jordan's financial trends. Meanwhile, insights about individual sectors' contributions to the economy are provided by the sector-specific indices [4]. The Banking, Industry, Service, Mining and Extraction, and Utility and Energy sectors carry most importance because of their prominent roles in driving country's economic activity and supporting the nation's developmental goals.

The banking sector is a cornerstone of Jordan's financial system, contributing approximately 15% to the national GDP, according to the Central Bank of Jordan. This sector is characterized by robust regulatory frameworks and high liquidity levels, enabling it to effectively support economic development. Jordan's banking institutions also play a critical role in facilitating foreign investment and fostering economic integration with global markets [5]. The industrial sector is also close to 17% of Jordan's GDP, and it forms an essential development pillar for the economy. This sector consists of diversified manufacturing industries like pharmaceuticals, chemicals, and textiles that also contribute to making exportation better. Government initiatives toward supporting the development of the industrial sector have also ensured this sector becomes well-entrenched in the economy. With international repute in pharmaceuticals, Jordan has come forth as one of the most important export-oriented producers of quality medical products, exporting to regional as well as global markets [6].

Jordan's service sector is the largest portion of its economy, holding about 60% of the country's GDP. It draws strength from solid cultural and historical backgrounds that include Petra and the Dead Sea. The World Travel and Tourism Council has recorded that the sector contributes roughly 19% to the GDP of Jordan and forms a very important source of revenue [7]. Apart from tourism, financial services, healthcare, and education are the sectors through which the service sector creates jobs and generates income, making it a sector central to driving economic growth. The resilience of such a sector has been essential to sustaining economic stability, primarily during periods when regional instability prevailed [8].

The mining and extraction industry is of strategic importance to Jordan. It forms almost 10% of the GDP of the country. Jordan ranks among the world's producers of phosphate and potash, which are essential constituents of fertilizers. This resource is significant in that it not only contributes to the country's exports but also enhances the trade status of Jordan internationally. This sector is Jordan's prime source of foreign exchange earnings and has tremendous potential for further development due to increasing world demand for mineral-based products [9].

The utility and energy sector plays a critical role in supporting Jordan's economic development and sustainability goals. While the country imports a substantial portion of its energy requirements, it has made significant strides in adopting renewable energy solutions to reduce its dependence on imports [10]. Investments in solar and wind energy projects have gained momentum, reflecting Jordan's commitment to diversifying its energy portfolio and achieving long-term sustainability.

Analyzing the cointegration of the Jordan Benchmark Index with its sector-specific indices is essential for understanding the structural interdependencies within the country's economy. The interplay between these indices provides critical insights into how sectors influence each other and contribute to overall economic performance [11]. This study examines the relationship between the benchmark index and the indices for Banking, Industry, Service, Mining and Extraction, and Utility and Energy to identify the extent of their integration and mutual dependencies. Such an analysis is crucial for assessing the efficiency of Jordan's financial markets and understanding the dynamics that drive sectoral performance.

The study need arises from the increasing significance of sectoral interdependencies in influencing investment strategies and economic policies [12]. The study contributes to the academic discourse on financial market efficiency and sectoral nexus, specifically in the context of Jordan, which is one of the promising emerging nations in the MENA region, by exploring the cointegration among selected indices. The study findings have relevant implications for multiple stakeholders. This will help investors offer direction towards diversified portfolio strategies and risk management. Policymakers will make use of such insights in structuring focused interventions to spur sectoral growth with better economic resilience. Academically, the work contributes to the body of literature concerning financial integration and market dynamics in emerging markets.

2. Review of Literature

Cointegration is one of the crucial concepts in financial market analysis to understand long-term interlinkages among various economic and financial variables. Its application delivers a crucial insight into the interdependencies between market indices, sectors, and more significant economic trends [13, 14]. The structural interdependencies and dynamic changes in sectoral roles have placed such markets in greater focus, such as in the case of Jordan's financial market [15]. The studies on cointegration, which focus on Jordan's Benchmark Index as well as its key sectoral indices, namely Banking, Industry,

Services, Mining and Extraction, and Utilities and Energy, are of great importance for portfolio optimization, market efficiency, and policy formulation.

The theory of cointegration, as espoused by Engle and Granger [16], shows that there are some long-term equilibrium relationships between the non-stationary time series [17]. Financial markets are volatile and non-stationary, but the variables involved could reflect a kind of hidden equilibrium over time. This is particularly pronounced in emerging markets, where economic transition and sectoral imbalances determine financial integration [18]. For example, sectoral indices from Jordan-banking, industry, and utilities-will form the foundation on which dependencies as well as common trends critical to an appreciation of market dynamics will be evaluated.

In fact, cointegration studies in the financial markets around the globe have enlightened the interconnectedness of global markets, though regional differences are observed Esmalifalak and Moradi-Motlagh [19]. Kasa [20] demonstrated that financial globalization promotes market integration and has resulted in increasingly interdependent markets [21]. In like manner, Johansen's multivariate cointegration approach has played a significant role in studying complex financial systems and offering robust methodologies for the analysis of sectoral integration, market efficiency, and systemic risks [22]. These approaches are now standard in investigating the long-term relationships between market indices.

Cointegration research in the context of emerging markets has been pivotal in determining how financial markets drive and reflect economic growth [23]. For example, Nautiyal and Kavidayal [24] demonstrated how sectoral indices, such as banking and energy, influence the overall movement of markets in India and provide insights into portfolio diversification and sectoral growth strategies [24]. In a similar vein, researchers in their study used cointegration to predict market downturns and identify resilient sectors during crises [25].

Sectoral analysis is essential in understanding how individual sectors contribute to the overall market. Among the most important sectors driving financial stability and economic resilience, the banking sector has been studied extensively for its impact on market integration, Antoniou et al. [26]. Ahmed [27] analyzed the cointegration of banking indices with market benchmarks in Pakistan, finding that the regulatory frameworks and liquidity of the banking sector have a significant impact on market stability [27]. Of importance, especially here in Jordan, where the sectors accounting for about 15 percent of GDP are banking-related, is the role played by banking in economic resilience and integration.

Other sectors, such as mining, utilities, and services present cointegration patterns which have structural characteristics and are subject to external dependence [28]. The mining sectors are usually pegged to the international commodity markets and co-integrate with the benchmarks of the market, but face volatility that results in risks in the systems [29]. Most researches into the economies dependent on resources point out a similar role in the aspect of export revenues and in economic growth that is implied by the complexities in it Tabash et al. [30]. The study for Jordan finds that mining and extraction indices to adversely affect the benchmark index in the long run and are sensitive to external shocks.

The utility and energy sector plays a dual role in furthering economic development as well as sustainability [31]. Studies undertaken for developed and emerging markets reveal that utility indices are generally cointegrated with market benchmarks in most instances, but in some cases, it heavily depends on the framework of regulation and energy policies at hand [32]. Studies into Gulf Cooperation Council countries highlighted regional markets' influence under which oil and gas indices reside [33]. This trend in the utility and energy sector, therefore, underpins the shift towards a more sustainable economy in Jordan, wherein renewable energy projects are gaining momentum. Inefficiencies in this sector are, therefore, further echoed in the findings of this study, with the sector having a negative long-term impact on the benchmark index [34].

Service sectors, including tourism, financial services, and education, are essential to the emerging markets' economic growth. Few studies on BRICS nations indicate the cointegration dynamics of service indices and thus show the significance of service sectors in employment and revenue [35, 36]. The Jordanian service sector is roughly 60 percent of the GDP, and thus, this trend is very important for the country's economic stability and growth. The positive long-term correlation between the service index and the benchmark index in Jordan also reflects the strength of that sector [37].

Methodologically, the standard techniques used in studying cointegration include robust econometric methodologies, including the Johansen Cointegration Test, Vector Error Correction Model (VECM), and Granger Causality tests [38, 39]. These methods allow for the investigation of long-term relationships and short-run dynamics betwixt indices Nkalu et al. [40]. Patel [41] used these tools to analyze the effectiveness of financial integration in Indian stock markets. The Jordanian study uses daily closing values over a longer period, which improves its ability to capture market volatility and sector interdependencies, hence providing information for investors and policymakers alike [42].

The implications of cointegration findings extend beyond the classroom setting. To the investor, long-run relationships among indices become part and parcel of portfolio diversification and risk management [43]. According to Nautiyal and Kavidayal [24], knowledge of a portfolio of sectors that are uncorrelated with each other maximizes returns since it reduces exposure to systemic risk. Policymakers can leverage cointegration analysis to inform targeted interventions that enhance sectoral efficiency and economic resilience [44]. Studies in South Africa have shown how cointegration insights can guide monetary policy by identifying sectors critical for economic stability [45]. In Jordan, understanding the positive contributions of banking, industry, and services can help policymakers allocate resources effectively, fostering balanced growth [46]. Addressing inefficiencies in mining and utilities could further enhance their integration into the broader market.

Despite these insights, there are still some gaps in the literature. Most of the existing research relates to developed or large emerging markets, leaving smaller economies like Jordan underexplored. Moreover, the function of sectoral indices in determining cointegration dynamics has not received enough attention. This paper tries to fill these gaps using an extended period of analysis on cointegration between Jordan's benchmark index and its main sectoral indices. It provides an exhaustive understanding of interdependencies in Jordan's financial sectors through applying advanced techniques of econometrics and yields useful insights for practical applications by investors and policymakers in addition to academic research purposes.

3. Research Aim and Methodology

The study aims to investigate the cointegration and causal associations between the Jordan benchmark index (Amman_Se) and its five major sectoral indices, namely the Jordan Bank Index (AMBX), Jordan Service Index (AMSX), Jordan Industry Index (AMIDX), Jordan Mining and Extraction Industries Index (AMMEIX), and Jordan Utility and Energy Index (AMUEX). These five key industries were chosen due to their importance to Jordan's GDP, the availability of data for the chosen study period, and their respective index values, which are typically greater than those of other Jordanian sectoral indices. The study's data set spans the period from January 1, 2013, to June 30, 2024. The indices are analyzed based on their daily closing values, obtained from Investing.com, to determine their financial integration and to evaluate the implications for investors and policymakers in Jordan.

To achieve the research objectives, advanced econometric techniques are employed. Initially, the Augmented Dickey-Fuller (ADF) statistics are used to examine the unit root in the data series. Covariance and correlation analyses identify the relationships between the indices. The Johansen Cointegration Test is conducted to assess the presence of long-run equilibrium associations, while the Vector Error Correction Model (VECM) evaluates the long-run dynamics among the selected indices. The Granger Causality test is applied to ascertain directional causality among the indices. Lastly, diagnostic tests including residual normality, serial correlation, and heteroscedasticity statistics techniques are applied to validate the VECM's reliability. Numerous researchers use the techniques under consideration for similar studies conducted on the financial markets of different countries or periods that support the validity of the identified research methodology [47-51].

The study follows a descriptive research design as it applies econometric techniques through EViews 11 to analyze the temporal relationships between the selected indices. The outcomes are expected to provide a deeper understanding of financial integration within Jordan's stock market, offering insights into hedging strategies, portfolio diversification, and policy formulation.

4. Data Analysis

4.1. Jordan Indices: Graphical Representation

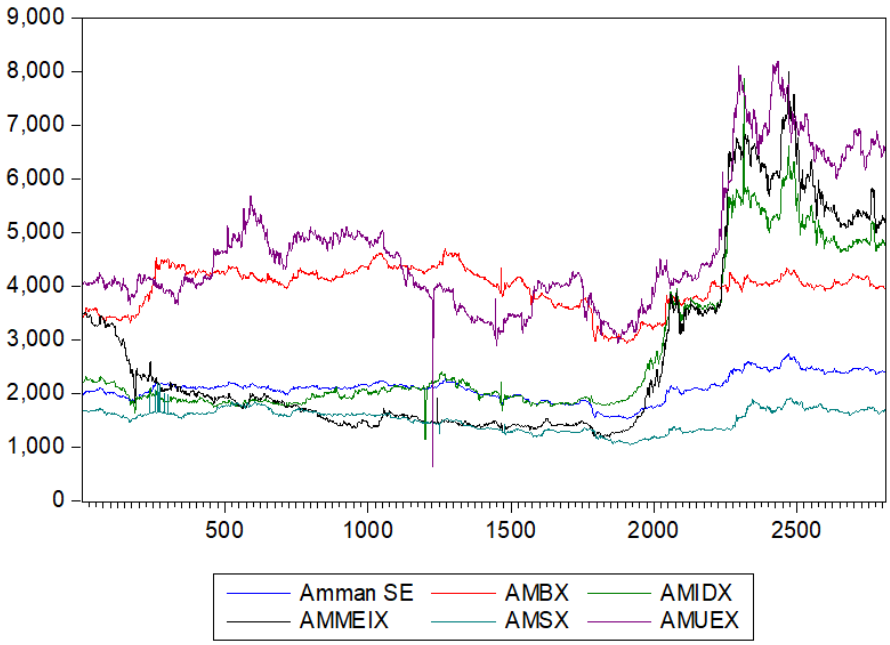

Figure 1.
Closing Values of Jordan benchmark index (Amman_Se) and Jordan's sectoral indices.

Figure 1 shows the closing values of the Jordan benchmark index (Amman_Se) and sectoral indices (AMBX, AMSX, AMIDX, AMMEIX, and AMUEX) during the study period. This figure illustrates the trends and fluctuations in the chosen indices daily closing values, highlighting similarities and deviations across the indices. Among all selected indices, Amman_Se is found to be more stable. Figure 1 depicts that there are possibilities of existence of nexus between the selected sectoral indices with the Jordan benchmark index.

Table 1.
Descriptive Statistics.

	AMMAN_SE	AMBX	AMIDX	AMMEIX	AMSX	AMUEX
Mean	2109.190	3986.732	2765.329	2751.886	1527.573	4701.102
Median	2115.620	4085.390	2050.740	1913.830	1600.190	4221.290
Maximum	2744.840	4715.870	7874.750	8017.490	2210.480	8204.700
Minimum	1533.350	2939.800	1162.420	1201.740	1049.770	632.1000
Std. Dev.	242.5034	386.9408	1337.624	1746.557	205.1228	1217.453
Skewness	-0.030096	-0.879170	1.260768	1.190284	-0.377844	1.005189
Kurtosis	3.011365	3.060430	3.020648	2.986896	2.213949	3.113139
Jarque-Bera	0.439167	362.2923	744.2175	663.3072	139.1555	474.5361
Probability	0.802853	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	5924715.	11198730	7767809.	7730048.	4290951.	13205397
Observations	2809	2809	2809	2809	2809	2809

Table 1 provides the critical descriptive statistics of the Jordanian indices for the study period. AMUEX has the highest mean value at 4701.102 and maximum at 8204.700, which suggests that AMUEX dominates the market. The standard deviation is greater for AMMEIX (1746.557) and AMIDX (1337.624), which explains more volatility compared to other indices. Skewness and Kurtosis show asymmetry and abnormality in the distributions, most so for AMIDX and AMMEIX. The Jarque-Bera test has confirmed non-normality of most indices at p value less than 0.05, except for Amman_Se (with p value equal to 0.802). Statistics like this are high variance and represent risk-reward opportunities to invest.

Table 2.
Covariance Analysis.

Covariance						
Correlation	**AMMAN_SE**	**AMBX**	**AMIDX**	**AMMEIX**	**AMSX**	**AMUEX**
AMMAN_SE	58786.95					
	1.000000					
AMBX	61239.88	149669.9				
	0.652870	1.000000				
AMIDX	243589.3	42797.02	1788601.			
	0.751210	0.082716	1.000000			
AMMEIX	324258.9	29788.47	2258918.	3049375.		
	0.765854	0.044094	0.967249	1.000000		
AMSX	38141.96	45619.26	85651.75	155266.7	42060.39	
	0.767054	0.574969	0.312279	0.433547	1.000000	
AMUEX	250509.0	142247.6	1376491.	1818860.	157526.6	1481663.
	0.848805	0.302067	0.845555	0.855695	0.631019	1.000000

The covariance and correlation matrix depicted in Table 2 shows the interaction between the indices of Jordan. The largest covariance exists between AMMEIX and AMIDX (3,048,375), which signifies strong co-movement. AMMAN_SE also shares significant covariance with AMMEIX (324,258.9) and AMUEX (250,509.0), signifying their influence on the benchmark index.

Correlation coefficients provide additional insights. AMMAN_SE exhibits a strong positive correlation with AMUEX (0.848805) and AMMEIX (0.765854), indicating these indices align closely with the overall market. Notably, AMIDX and AMMEIX display the highest inter-sector correlation (0.967249), suggesting shared economic drivers. Conversely, AMSX and AMBX correlations with other indices are moderate, implying potential diversification opportunities.

These patterns highlight AMUEX and AMMEIX as the pattern formers of market trends thus making them strategic focus points for investors and policymakers. Moreover, the observed correlations highlight integrated sectoral performance critical for market stability and for intervention policies.

4.2. VECM by taking Amman_SE as Target Variable

4.2.1. Augmented Dickey-Fuller Unit Root test

$H_{01:}$ Considered data of selected Jordan indices is non-stationary.

$H_{a1:}$ Considered data of selected Jordan indices is stationary.

Table 3.
ADF Unit root test Statistics of selected indices.

Indices	Original data of selected indices			Adjusted data (with First Difference)		
	t-Statistic	Probability	Result	t-Statistic	Probability	Result
Amman_Se	-1.134474	0.7024	H01 is not rejected	-44.31673	0.0001	Stationary
AMBX	-1.982362	0.2948	H01 is not rejected	-55.04282	0.0001	Stationary
AMSX	-1.502745	0.5323	H01 is not rejected	-9.536018	0.0000	Stationary
AMIDX	-0.493968	0.8900	H01 is not rejected	-32.48059	0.0000	Stationary
AMMEIX	-0.373902	0.9112	H01 is not rejected	-47.45344	0.0001	Stationary
AMUEX	-1.02155	0.7476	H01 is not rejected	-37.71174	0.0000	Stationary

According to statistics in Table 3, the daily data series for all chosen variables are determined to be stationary at I(1) over the underlying study period since H01 is rejected for indices at I(1) at a 5% significance level. Therefore, it is appropriate to proceed for the VECM analysis.

4.3. Optimum Lag Pick Criteria

Table 4.
VAR Lag Order Selection Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-116798.5	NA	5.95e+28	83.28308	83.29578	83.28766
1	-84294.34	64846.12	5.25e+18	60.13286	60.22179	60.16496
2	-83487.33	1606.533*	3.03e+18	59.58312*	59.74828*	59.64273*
3	-83135.68	698.5473	2.42e+18*	59.35806	59.59944	59.44518
4	-83059.51	150.9664	2.35e+18	59.32942	59.64702	59.44405

Since lag 2 satisfies most of the requirements, including the Hannan-Quinn information criterion (HQ), the Akaike information criterion (AIC), the Schwarz information criterion (SC), and the sequential modified LR test statistic (LR), it is selected for the subsequent steps to apply VECM based on the VAR lag order results displayed in Table 4.

4.4. Johansen Cointegration Test

H02: There is absence of significant cointegration between the selected indices of Jordan.
Ha2: At least one significant cointegration exists in selected indices of Jordan.

Table 5.
Johansen Cointegration (Unrestricted Rank Test) (Lag 2).

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.064886	297.5506	95.75366	0.0000
At most 1 *	0.022725	109.3050	69.81889	0.0000
At most 2	0.007708	44.80210	47.85613	0.0941
At most 3	0.005733	23.08974	29.79707	0.2417
At most 4	0.001659	6.957611	15.49471	0.5826
At most 5	0.000819	2.299608	3.841466	0.1294

As per the Trace statistics of Johansen Cointegration test given in Table 5, H02 is rejected at 0.05 level. The results signify at most two long run cointegration equations exists between the selected Jordan indices.

Table 6.
Johansen Cointegration (Unrestricted Rank Test) (Lag 2).

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.064886	188.2456	40.07757	0.0001
At most 1 *	0.022725	64.50292	33.87687	0.0000
At most 2	0.007708	21.71235	27.58434	0.2355
At most 3	0.005733	16.13213	21.13162	0.2172
At most 4	0.001659	4.658002	14.26460	0.7842
At most 5	0.000819	2.299608	3.841466	0.1294

As per the Maximum Eigenvalue statistics of Johansen Cointegration test given in Table 6, H02 is rejected at 0.05 level. The results signify at most two long run cointegration equations exists between the selected Jordan indices.

Table 7.
Normalized Cointegration Equation.

Cointegrating Equation(s):	Log likelihood	-83219.54		
Normalized cointegrating coefficients (standard error in parentheses)				
AMMAN_SE	AMBX	AMIDX	AMMEIX	AMSX	AMUEX
1.000000	-0.221543	-0.163667	0.024823	-0.603828	0.040378
	(0.00994)	(0.01186)	(0.00870)	(0.02952)	(0.00528)

As per the results of Table 7, in the long run, the performance of Jordan's benchmark index (AMMAN_SE) will be positively influenced by the performance of Jordan's three sectoral indices viz. AMBX (Banking), AMIDX (Industry) and AMSX (Service). However, AMMEIX (Mining and Extraction) and AMUEX (Utility and Energy) will have negative impact on the performance of AMMAN SE General index on average ceteris paribus (as they are just OLS estimates).

4.5. VECM Jordan benchmark index (AMMAN_SE) as Target Variable

4.5.1. Long-run Model: Cointegrating Equation

ECT_{t-1} = 1.0000*$AMMAN\_SE_{t-1}$ – 0.221443*$AMBX_{t-1}$ – 0.166789*$AMIDX_{t-1}$ + 0.027487*$AMMEIX_{t-1}$ – 0.596946*$AMSX_{t-1}$ + 0.0038223*$AMUEX_{t-1}$ – 108.5904

Estimating VECM with AMMAN_SE as target Variable

$\Delta AMMAN\_SE_t$ = -0.015759ECT_{t-1} + 0.011143$\Delta AMMAN_SE_{t-1}$ + 0.175842$\Delta AMBX_{t-1}$ -0.005063$\Delta AMIDX_{t-1}$ + 0.070895$\Delta AMMEIX_{t-1}$ - 0.010152$\Delta AMSX_{t-1}$ - 0.001074$\Delta AMUEX_{t-1}$ + 0.070059

D(AMMAN_SE) = C(1)*(AMMAN_SE(-1) - 0.221443299436*AMBX(-1) - 0.166789369749*AMIDX(-1) + 0.0274866162927*AMMEIX(-1) - 0.596945989468*AMSX(-1) + 0.0382225201424*AMUEX(-1) - 108.590417447) + C(2)*D(AMMAN_SE(-1)) + C(3)*D(AMBX(-1)) + C(4)*D(AMIDX(-1)) + C(5)*D(AMMEIX(-1)) + C(6)*D(AMSX(-1)) + C(7)*D(AMUEX(-1)) + C(8)

Table 8.
VECM for Shanghai as Target Variable.

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	-0.015759	0.005029	-3.133559	0.0017
C(2)	0.011143	0.016945	0.657591	0.5109
C(3)	0.175842	0.006958	25.27314	0.0000
C(4)	-0.005063	0.002544	-1.990219	0.0467
C(5)	0.070895	0.003545	19.99894	0.0000
C(6)	-0.010152	0.005546	-1.830617	0.0673
C(7)	-0.001074	0.001555	-0.690686	0.4898
C(8)	0.070059	0.161626	0.433464	0.6647
R-squared	0.310207	Durbin-Watson stat		2.142874
Adjusted R-squared	0.308482			
F-statistic	179.8201			
Prob(F-statistic)	0.000000			

The Coefficient of ECT (Error Correction Term) in Table 8, C(1), is found to be negative and significant at 0.05 level, suggesting long-term causation and cointegration between the chosen sectoral indices and the benchmark index of Jordan. The value of R-squared implies that 31 percent variation in AMMAN_SE index is explained by the five selected sectoral indices. P-value of F-statistics signifies that the VECM model is good fit at 0.05 significance level signifying its adequacy in explaining the relationships among selected indices. The value of Durbin-Watson statistic (2.14) depicts the data does not have autocorrelation problem. The absence of autocorrelation in residuals confirms the reliability of the estimates.

4.6. Validating the VECM: Residual Diagnostics Test

To confirm the validated of the aforementioned VECM model given in Table 8, a number of tests have been run on its residuals. In order for a VECM to be considered genuine and authentic, the residuals' series must be normally distributed and free of serial correlation and heteroscedasticity. The normality of residuals is examined using the VEC Residual Normality test. At a 5% significance level, the results show that the Jarque Berra component value validated the residuals' normal distribution. Other required tests are applied in ahead sections of the study.

4.7. Breusch-Godfrey Serial Correlation LM Test

H03: Residuals are free from the serial correlation issue.

Ha3: Residuals have significant serial correlation issue.

Table 9.
Breusch-Godfrey Serial Correlation LM Test.

F-statistic	0.173647	Prob. F(2,2797)	0.6671
Obs*R-squared	0.188861	Prob. Chi-Square(2)	0.6560

As per the Prob. F value and Prob. Chi-Square value presents in Table 9, Ha3 is rejected at 0.05 level of significance. It suggests that the serial correlation issue is not present in the generated VECM model.

4.8. Heteroscedasticity Test

H04: Residuals are free from Heteroscedasticity issue.
Ha4: Residuals have significant Heteroscedasticity issue.

Table 10.
Breusch-Pagan-Godfrez Test Statistics.

F-statistic	1.317012	Prob. F(12,2794)	0.2834
Obs*R-squared	12.35764	Prob. Chi-Square(12)	0.2768
Scaled explained SS	29.13212	Prob. Chi-Square(12)	0.0014

As per the results given in Table 10, the Prob. Chi-Square is 0.2768, so Ha4 is rejected at 0.05 level. It signifies that the derived VECM model does not have Heteroscedasticity issue as residuals are free from the same.

4.9. Stability Diagnostics for Model

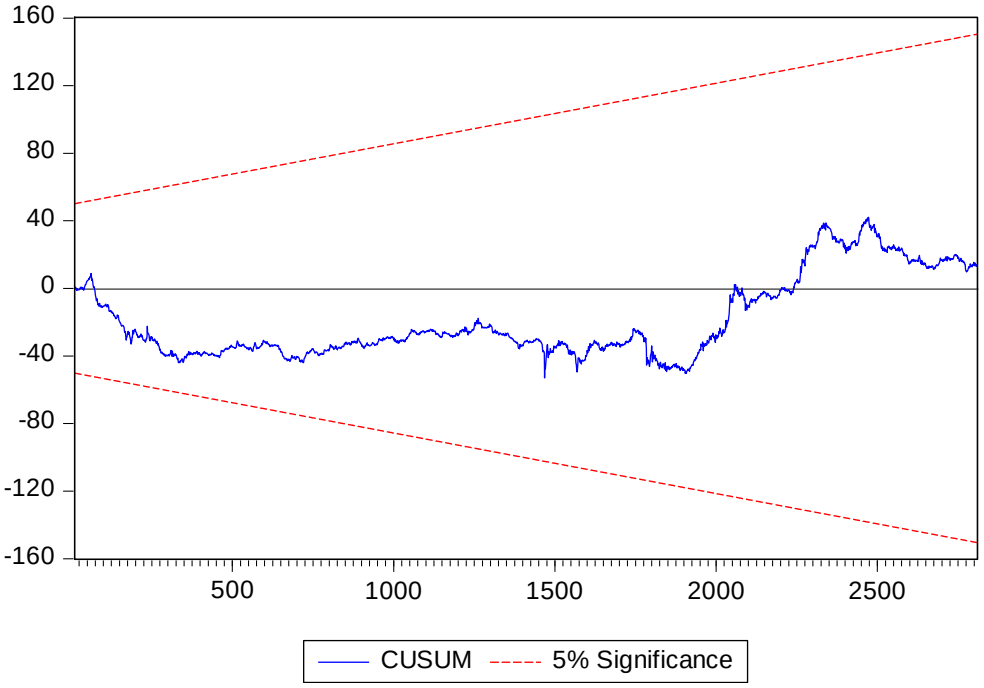

Figure 2.
CUSUM Stability Diagnostics Model

The VECM model for estimating the closing value of the AMMAN_SE Index is stable, as shown in the Figure 2. As a result, the derived model's dynamic stability is confirmed.

4.10. Granger Causality Test (Post-Spread COVID-19 Pandemic Period)

H05: No significant causal association exists among selected sectoral indices pairs of Jordan with Jordan benchmark index (AMMAN_SE).

Ha5: Significant causal association exists among selected sectoral indices pairs of Jordan with Jordan benchmark index (AMMAN_SE).

Table 11.
Granger Causality Test.

H0:	Obs.	F-Statistic	Prob.
AMBX is not Granger Causing AMMAN_SE	2807	271.132	0.0000
AMMAN_SE is not Granger Causing AMBX		47.5043	0.0000
AMIDX is not Granger Causing AMMAN_SE	2807	47.0246	0.0000
AMMAN_SE is not Granger Causing AMIDX		0.09877	0.9060
AMMEIX is not Granger Causing AMMAN_SE	2807	185.988	0.0000
AMMAN_SE is not Granger Causing AMMEIX		1.24144	0.2891
AMSX is not Granger Causing AMMAN_SE	2807	0.54929	0.5774
AMMAN_SE is not Granger Causing AMSX		12.3045	0.0000
AMUEX is not Granger Causing AMMAN_SE	2807	8.99620	0.0001
AMMAN_SE is not Granger Causing AMUEX		1.31687	0.2681
AMIDX is not Granger Causing AMBX	2807	6.23902	0.0020
AMBX is not Granger Causing AMIDX		2.60450	0.0741
AMMEIX is not Granger Causing AMBX	2807	20.6619	0.0000
AMBX is not Granger Causing AMMEIX		10.3205	0.0000
AMSX is not Granger Causing AMBX	2807	0.63648	0.5292
AMBX is not Granger Causing AMSX		2.80416	0.0607
AMUEX is not Granger Causing AMBX	2807	0.57753	0.5614
AMBX is not Granger Causing AMUEX		0.20155	0.8175
AMMEIX is not Granger Causing AMIDX	2807	9.78628	0.0000
AMIDX is not Granger Causing AMMEIX		5.78802	0.0031
AMSX is not Granger Causing AMIDX	2807	0.77493	0.4608
AMIDX is not Granger Causing AMSX		2.17388	0.1139
AMUEX is not Granger Causing AMIDX	2807	2.36372	0.0943
AMIDX is not Granger Causing AMUEX		4.27114	0.0141
AMSX is not Granger Causing AMMEIX	2807	4.96044	0.0071
AMMEIX is not Granger Causing AMSX		3.45658	0.0317
AMUEX is not Granger Causing AMMEIX	2807	1.96633	0.1402
AMMEIX is not Granger Causing AMUEX		5.32986	0.0049
AMUEX is not Granger Causing AMSX	2807	6.91867	0.0010
AMSX is not Granger Causing AMUEX		0.34726	0.7067

Table 11 depicts Causality test statistics of Jordan benchmark index i.e. AMMAN_SE with other selected five sectoral indices and within the pairs of selected five Jordan sectoral indices. As per the results, bidirectional Granger causality relation is found to be shared among Jordon Banking sectoral index and Jordan Benchmark index (AMBX-AMMAN_SE) as H05 is rejected as per the Prob. value at 5 % significance level. However, unidirectional Granger causality is found to be running from Jordan Industry Index, Jordan Mining and Extraction Index and Jordan Utility and Energy Index to Jordan Benchmark index ("AMIDX→AMMAN_SE", "AMMEIX→AMMAN_SE", "AMUEX→AMMAN_SE") as H05 is rejected as per their respective Prob. Values at 0.05 level. On the other side, Jordan benchmark index is Granger causing variation in Jordan Service Index as unidirectional grander causality is found between Jordan benchmark index and Jordan Service index (AMMAN_SE→AMSX) as H05 is rejected for the same.

In context to causality relation within sectoral indices, significant bidirectional Granger causality is found to be present between Jordan Mining and Extraction Industries Index with Jordan Bank Index, Jordan Service Index and Jordan Industry Index ("AMMEIX-AMBX", "AMSX-AMMEIX", "AMMEIX-AMIDX" at 0.05 level. Further, significant unidirectional Granger causality is found to be running from Jordan Industry Index (AMIDX) to Jordan Bank Index (AMBX), Jordan Industry Index (AMIDX) to Jordan Utility and Extraction Index (AMUEX), Jordan Mining and Extraction Industries Index (AMMEIX) to Jordan Utility and Energy Index (AMUEX) and from Jordan Utility and Energy Index (AMUEX) to Jordan Service Index (AMSC) at 0.05 level.

Few pairs of Jordan sectoral indices are found to be independent as per the results of Granger causality test. Thus no granger causality if found among those sectoral indices pairs such as "AMSX & AMBX, AMUEX & AMBX, AMSX & AMIDX" as Ha5 is rejected at 5 % level of significance.

5. Discussion and Results

VECM is specifically appropriate for examining the nature of the nexus among cointegrated variables as it allows the examination of both equilibrium linkages and temporary deviations. This discussion emphasizes the ramifications of the results, highlighting the long-run equilibrium captured by the cointegrating equation and the adjustments made to restore it, while analyzing the short-term dynamics to gain a better understanding of the interdependencies between the selected indices. As per the results, the cointegrating equation unearths the long-term equilibrium nexus among the selected variables. The coefficient of the Error Correction Term (ECT) is found to be statistically significant and negative (0.015759), supporting the presence of a long-term linkage between AMMAN_SE and the selected five sectoral indices. This signifies that deviations

from the long-run equilibrium are corrected over time, with approximately 1.58% of the disequilibrium being corrected in each period. The slow correction or adjustment speed advocates that the Jordan stock market is comparatively lethargic in responding to long-run imbalances. Long-run linkages suggest that a one percent change in the Jordan Banking Index, Jordan Industry Index, and Jordan Service Index will result in positive variations in the closing values of the Jordan benchmark index by 0.221443 times, 0.166789 times, and 0.596946 times respectively in the long run. VECM results further reveal that a change in the Jordan Mining and Extraction Industries Index and the Jordan Utility and Energy Index will cause a decline of 0.027487 times and 0.0038223 times in the Jordan benchmark index in the long term. These conclusions are corroborated by the findings of Mugableh's past research [42, 52, 53].

The short-run dynamics of the VECM model exhibit varying impacts of Jordanian sectoral indices on the AMMAN_SE benchmark index. The Error Correction Term (ECT) is statistically significant, supporting the existence of cointegration and suggesting that deviations from long-run equilibrium are corrected over time. The banking index (AMBX) shows a statistically significant strong positive influence, where a one-unit increase in its lagged change results in a 0.175842 unit rise in the Jordan benchmark index. However, the industrial index (AMIDX) exhibits a small but statistically significant negative relationship with the benchmark index. A one-unit increase in AMIDX leads to a 0.005063 decline in AMMAN_SE. In the short run, the manufacturing index (AMMEIX) positively influences AMMAN_SE, with a one-unit increase causing a 0.070895-unit rise, depicting its short-term growth potential. In contrast, the services index (AMSX) has a marginally significant negative effect, reducing AMMAN_SE by 0.010152 units per one-unit increase. The utilities index (AMUEX) and the lagged AMMAN_SE do not have statistically significant short-term effects, indicating limited immediate relevance. These findings emphasize the diverse and sector-specific short-term dynamics influencing the Jordanian stock market.

The Granger causality test statistics pinpoint significant bidirectional causal nexus between the AMBX and AMMAN_SE, signifying mutual influence of both indices. AMIDX, AMMEIX, and AMUEX reveal unidirectional causality towards AMMAN_SE, highlighting their predictive power for Jordanian benchmark index movements. In contrast, AMMAN_SE significantly Granger causes AMSX, depicting its dominant role in shaping services sector dynamics. In the context of inter-sectoral linkages, AMMEIX Granger causes both AMBX and AMIDX, reflecting the mining and extraction sector's wider market influence. Similarly, AMIDX Granger causes AMMEIX, indicating interdependence between industrial and manufacturing sectors. Weak or no causality is observed in a few cases, such as AMSX failing to Granger cause AMBX or AMMEIX, underscoring limited sectoral interaction. These results suggest the banking and mining sectors are pivotal for short-term predictive insights, while other sectors like services and utilities play more limited roles in driving the benchmark index of Jordan or influencing inter-sectoral dynamics.

6. Managerial and Policy Implications of the Findings

The study findings are valuable insights into the dynamics between the Jordanian benchmark index and its key sectoral indices, providing crucial inferences for portfolio diversification, investment strategies, and policy formulation. From the cointegration analysis, long-run relationships are manifested, where the banking, industrial, and service sectors positively influence the benchmark index in the long run; however, on the other hand, the mining and extraction, and utility and energy sectors negatively influence it. These results point to a nuanced interplay where certain sectors offer growth opportunities while other sectors showcase inefficiencies that require strategic attention.

The banking sector constitutes the largest short-term driver in the Jordanian stock market, with a strong positive impact upon AMMAN_SE in short-run periods. This results in investors, both domestic and international alike, focusing on these stocks in the short run due to gains, but remaining worried about the long-run prospects affecting the overall market trend. Similarly, the mining and extraction sector has good predictive power for the benchmark index and hence is another strategic area for short-term investments. The strong inter-sectoral linkages, such as the influence of the mining sector on both industrial and banking indices, point towards the fact that well-informed investors can leverage these relationships to optimize their portfolios. The strong correlation between AMMAN_SE and AMUEX suggests that utility and energy stocks can be a stabilizing component of diversified portfolios, offering risk-averse investors a hedge against volatility in other sectors.

Portfolio diversification benefits also emerge prominently from the findings. Mixed causality relationships among the sectoral indices, as inferred by the Granger causality test, highlight the possibilities of designing diversified investment strategies. For example, due to the minimum interaction between the services and mining sectors, such sectors can be pooled in a balanced portfolio for less exposure to risk. This can thus allow international investors to search for sectors with lower correlation but with strong individual performances in which they can minimize risk while also capitalizing on growth.

The relatively slow adjustment speed of the Jordanian stock market, as indicated by the Error Correction Term (ECT), further underscores the importance of developing a resilient market infrastructure. Policymakers should focus on improving market liquidity and efficiency, ensuring that shocks to the system are absorbed and corrected more rapidly. Regulatory measures encouraging cross-sector collaboration and innovation can also enhance the interdependence and stability of Jordan's key economic sectors.

7. Conclusion

This study explains the long-term and short-term dynamics between the Jordanian benchmark index and its major sectoral indices, providing critical insights into the financial interconnections within Jordan's economy. Long-run equilibrium nexus and deviations are quantified through the Vector Error Correction Model, highlighting the critical role of banking, industrial, and service sectors in driving positive variations in the Jordan benchmark index. In contrast, negative effects from the mining and utility sectors highlight areas needing attention to curb inefficiencies and improve performance. Granger causality statistics depict significant causal relationships, with bidirectional relationships among AMBX and AMMAN_SE

underpinning the banking sector's influence. The unidirectional causality from industrial, mining, and utility indices to the benchmark index further reinforces their predictive value. The study findings provide worthwhile implications for portfolio diversification, revealing that the mining and utility sectors provide diversification benefits as they share a negative relation with the benchmark index. Thus, these two sectoral indices offer higher short-term returns despite their long-run challenges. While the banking, service, and industrial sectors share a positive linkage with the benchmark index, this limits the portfolio diversification benefits. Domestic and foreign investors can use these identified patterns to frame strategies balancing growth and risk to ensure optimal outcomes. Policymakers and regulators of Jordan can leverage these insights to craft targeted interventions focusing on fostering sectoral efficiency, enhancing market resilience, and promoting cross-sector synergies. Jordan's financial system can gain sustainable growth by addressing inefficiencies and bolstering underperforming sectors, as the majority of sectoral indices significantly cause variations in its benchmark index, as per the study results. Thus, the study's findings reflect both potentials and limitations within Jordan's stock market. Policymakers and investors can foster a more stable and growth-oriented financial environment in Jordan by focusing on sector-specific inefficiencies, encouraging cross-sector synergies, and leveraging insights into sectoral interdependence.

8. Limitations and Future Scope of the Study

The present study, although offering valuable insights into Jordan's financial market, has certain limitations. Primarily, the data is confined to the daily frequency of selected indices over the study period. It has overlooked the broader macroeconomic factors such as exchange rates, inflation, GDP (Gross Domestic Product) growth rates, interest rates, or other geopolitical risks. Additionally, only five sectoral indices are considered, which restricts the model's ability to predict unforeseen market disruptions caused by unselected sectoral indices.

The present study can be expanded by incorporating macroeconomic variables like exchange rates, inflation, GDP (Gross Domestic Product) growth rates, interest rates, etc., to offer a more comprehensive analysis. High-frequency data can be considered to enhance the understanding of evolving market dynamics. Furthermore, other regional markets and sectoral indices can be considered for making comparative analyses, as they may offer a broader perspective and help identify unique and linked patterns in financial integration and portfolio strategies.

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