LONG-TERM AND SHORT-TERM RELATIONSHIPS BETWEEN THE US STOCK MARKET AND MACROECONOMIC VARIABLES: AN EMPIRICAL STUDY

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ABSTRACT

From an economic perspective, it is of interest to determine if two non-stationary economic time series are co-integrated. Two non-stationary series are co-integrated if a linear combination of the two series is long-term stationary. In this study, we test for co-integration and long-term relationships between macroeconomic variables, including the Dow and S&P 500, using the Johansen co-integration test and the vector error correction model, VECM. Also, we investigate short -term relationships between these variables, using the Granger test and VECM.

Results show that GDP is co-integrated with Dow, S&P 500 (SP), savings deposits, CPI, and debt. Also, Dow is co-integrated with SP, savings deposits, and debt. The SP index is co-integrated with debt, savings deposits, and CPI. Estimates of the long-term relationships between variables and rates of error adjustments are presented. Also, short-term relationships, from the Granger test and the VECM analysis are presented and compared.

INTRODUCTION

The stock market and the GDP play an important role in a country's economic and industrial growth. The long-term relationships, or equilibrium links, between stock market indexes and macroeconomic variables, are of importance to the economy of a country and to investment in financial markets. A long-term relationship, or co-integration, between stock market indexes and macroeconomic variables, can aid in predicting the behavior of an index according to the behavior of a macroeconomic variable since the two variables have a common trend in the long run. The interest in looking for common characteristics of two series, from which one can draw conclusions about their behaviors, leads to the concept of co-integration between the two series. From the point of view of economics, two series are co-integrated if they move together over time and the linear combination between them is stationary or stable. Hence, the two series have a long-term equilibrium towards which the economic system converges over time.

Relationships between economic time series can vary from country to country and from one time-period to another. Most of the studies on co-integration between macroeconomic variables are done in developing markets and little recent work is done on co-integration between economic variables in the US. Due to the relative lack of empirical studies on the long-term relations between economic variables, we investigate in this paper the long-term or equilibrium relationships between the Dow index, S&P index, the GDP, and macroeconomic variables using the Johansen co-integration test and the vector error correction model (VECM).

LITERATURE REVIEW

Hacker and Hatemi (2003) investigated in one set of variables, the co-integration of Swedish real exports, real GDP, and foreign real GDP. Also, they considered, in another set, the co-integration of Swedish real exports, total factor productivity, and foreign real GDP. Foreign real GDP was estimated as the total OECD real GDP minus Sweden's real GDP. Using the Johansen multivariate co-integration tests (trace and eigenvalue tests), the authors showed that the three variables within each set were co-integrated. There was only one co-integration vector in both sets. The Granger causality test showed that there was a bi-directional causality between real GDP and real exports and between real GDP and total factor productivity. Also, foreign real GDP Granger-caused real exports.

Markellos (1999) used co-integration to evaluate the performance of an investment strategy. The author argued that for an investment strategy to be successful, its cumulative returns over time should outperform the market cumulative returns and the two series should not be co-integrated. This is so since co-integration means that investment returns are tied to the market returns.

The author applied this co-integration test to evaluate various investment rules using the DJIA and the FT30 index on the London Stock Exchange. It should be remarked that cumulative returns of an investment strategy can be co-integrated with the market returns and still outperform the market. However, in this case, the difference between the investment returns and the market returns are positive but stationary over time, since the two series are co-integrated. In this case, although the investment strategy is still successful, it cannot break away from the market.

Ratanapakorn and Sharma (2007) investigated the long-term relationship between the S&P 500, stock price index, and six macroeconomic variables over the period 1975-1999. The authors applied the multivariate Johansen co-integration tests to determine the equilibrium or long-term relationships between variables. They reported that the S&P 500 price index was negatively related to the long- term interest rate but positively related to the money supply (M1), industrial production, inflation, the exchange rate, and the short-term interest rate.

Kaufmann (2004) applied a multivariate co-integration analysis of the vector error correction model (VECM) to determine the equilibrium relationships between heat measure of total energy use and types of fuels consumed (oil, gas, hydro, and nuclear), personal energy consumption expenditures, GDP, and energy prices. Four equilibrium vectors were identified based on the Johansen co-integration trace and eigenvalue tests. The first equilibrium or long-term relationship was between energy and personal consumption. The second long-term relationship was between energy and types of fuels consumed. The third long term relationship was between energy prices and energy use. The fourth long-term relationship was between energy use and price changes, GDP, and fraction of total energy consumption from oil and gas. These results indicated that energy use in the long run was associated with oil, gas and hydro and nuclear electricity. However, the model did not include coal under type of fuel consumed

Serfling and Miljkovic (2011) used co-integration analysis and the vector error correction model (VECM) to investigate the relationship between macroeconomic variables. The VECM model included the change in the dividend yield, the change in the yield on the 10-year Treasury note, the percentage change in the price level of the S&P 500 Index, the percentage change in the M1 money supply, interest rate, the percentage change in the industrial production index (IPI), and the percentage change in the CPI Results from the VECM analysis showed that change in dividend yield was affected by interest rate, money supply, and CPI. Change in yield on the treasury note was affected by dividend yield, interest rate, S&P 500 price, IPI, and CPI. Change in the S&P 500 price was affected by interest rate, money supply, IPI, and CPI. Current change in the money supply was affected by change in dividend yield, S&P 500, and CPI. Current change in the IPI was affected by interest rate and S&P 500. Change in CPI was affected by dividend yield, interest rate, S&P 500, and money supply. As such, the results showed feedback between variables.

Seabra (2001) investigated, using the Johansen co-integration test and the vector error correction model (VECM), the long-term relationships between the Argentine Merval, Brazilian Ibovespa, Japanese Nikkei, and US Dow Jones stock markets. Results showed that the Argentine and Brazilian stock markets were co-integrated with the US Dow Jones Industrial average. There was no co-integration between the other markets. Short-term results from the VECM indicated a stronger relationship between the Brazilian and Dow indexes than between the Dow and the Argentine stock market index.

Sahoo and Sahoo (2019) investigated the long-term relationship between unemployment rate in India and GDP, consumer price index (CPI), literacy rate, labor force, and domestic private investment formation. The data were over the period 1991-2017. The Johansen co-integration test and the VECM were used to study the co-integration and the long-term relationship between unemployment and the other variables. The co-integration test showed that long-term relationships existed among all the variables. The VECM results showed that unemployment was predictable by the explanatory variables in the model. The Granger test showed that GDP caused unemployment. There was a bi-directional causality between labor force and unemployment. Also, private investment, and labor force caused unemployment.

Maghrebi et. al. (2018) investigated the long-term and causal relationships between crude oil price and the GDP in Saudi Arabia, over the period 1998-2014. The Johansen co-integration analysis showed that crude oil price and GDP were co-integrated. Also, the Granger test indicated that there was a bi-directional relationship between crude oil price and GDP.

Huat and Wai (2009) studied the co-integration and causality between money supply (M1, M2, and M3) and GDP in Singapore. Data were quarterly over the period 1975 to 1998. M3 was co-integrated with GDP. The Granger causality test showed a bidirectional causality between M1 and GDP and a unidirectional causality from GDP to M2 and M3.

Ramdhan et al. (2018) investigated the co-integration relationships between the S&P 500 index and the GDP, inflation rate, broad money supply, and long term interest rate in the US. Also, the same relationships were investigated in Japan using the Nikkei 225 index. The study period was from 1990 until 2017 and data were quarterly. The authors used the Johansen (1988, 1991) co-integration tests and found that in both countries, there was co-integration between the US and Japan stock market indices and all macroeconomic variables. The US index and the Japanese index were positively related, in the long run, to each of the macroeconomic variables.

Malhotra (2018), using the Engle Granger residual based test of co-integration, reported that the BSE and Nifty Indian stock markets were co-integrated with the US NASDAQ and Dow Jones industrial average. This implied that these markets had long-term equilibrium relationships.

For the analysis, daily data were utilized for the period April 1, 2011 to October 31, 2017.

Kumar and Sahu (2017) reported on the co-integration between macroeconomic factors and the Islamic stock index on the Indian stock market. The macroeconomic factors considered were the whole sale price index, 365-day government of India T-bill rate, M3 money supply, exchange rate, and Dow Jones Islamic Market India Total Return Index. The study was on monthly data over the period January 2006 to July 2015. Johansen's multivariate co-integration test and the vector error correction model (VECM) were employed in the study. Results indicated that there were co-integration or long-term relationships between the Islamic stock index and whole sale price index, money supply, and interest rate (T-bill rate). The long-term relationships were positive for money supply and the whole sale price index and negative for the interest rate. The Granger causality test showed that money supply and exchange rate caused the Islamic India market index

Kisswani et al. (2015) examined the co-integration and causality between foreign direct investment (FDI) and GDP in Estonia. The quarterly data were over the period 1994-Q1 to 2013-Q2. Co-integration was determined by using the Engle and Granger residual-based test and the Johansen trace and eigenvalue tests. Also, the causal relationship was examined using the Granger test. Results of the Johansen tests showed that FDI and GDP were integrated with one integrating equation. The Granger causality test indicated that FDI caused GDP, but GDP did not cause FDI.

Camareroa et al. (2015) examined long-term or equilibrium relationships through co-integration between energy use and GDP for 15 EU countries. Applying a non-linear co-integration test (Chong, 2008), the authors reported co-integration between energy use and GDP for Spain, Austria, Denmark, Portugal and the Netherlands. These countries had the widest gap in meeting their targets of reduced emissions under the Kyoto Protocol.

Gopinathan et al. (2015) investigated the co-integration relation between the S&P 500 and the real GDP using quarterly data over the period 1970-Q1 to 2013-Q3. The authors examined the co-integration for the whole sample and for rolling samples of 100 observations over time. Results from the Johansen test indicated that the S&P 500 index was co-integrated with GDP for the whole period and for the window of 100 observations over time, except for the economic crisis period, 2008Q1 to 2008Q4, where no co-integration relationship existed between the two variables

Ivanov (2011) examined the influence of the crisis on financial markets by studying the co-integration relationship between the S&P 100 and S&P 500 indexes in extreme market conditions using the Johansen trace test. The author used one-minute interval data. Results showed that there was no co-integration between the two indexes for the day after Black Monday and the time of the Japanese earthquake.

DATA

Quarterly data over the years 1970-Q1 to 2018-Q1 were gathered on the following variables: S&P 500 (SP), Dow industrial average (Dow), GDP (billions), unemployment rate, savings deposits at commercial banks (billions), M2 money supply (billions), National debt (billions), inflation (CPI), crude oil import price in dollars per barrel, industrial production index, 10-year bond rate, trade balance(Millions), and federal fund rate. The data were retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org

METHODS

Dow, S&P, and GDP were tested for co-integration with each other and with each of the macroeconomic variables above. We report here on results from the Johansen co-integration test and the Vector Error Correction analysis concerning the variables that were co-integrated. Also, we report on the relationships between variables using the Granger test.

Co-integration and vector error correction model

Two non-stationary time series are co-integrated if there is a linear combination of the two variables that is stationary or I(0). Two co-integrated variables that are I(1) (i.e., stationary upon first difference) can be analyzed using the Vector Error Correction Model (Johansen, 1988, 1991). For two variables with one co-integrated vector, the model can be expressed as:

$$D\_Y_{it} = C + \alpha\beta' Y_{it-1} + \sum_{i=1}^{p-1} \delta i \, D\_Y_{it-1} + E \qquad (1)$$

Where C is a constant, D_Y_{it} is a 2x1 column vector of first differences for the two variables (y_{1t}, y_{2t}), α is a 2x1 column vector, β' is a 1x2 row vector, δ_i is a 2x2 matrix, and E is the random error term. The expression $\alpha\beta' Y_{it-1}$ gives the long-term relationship or equilibrium between the two variables, and $\sum_{i=1}^{p-1} \delta i \, D\_Y_{it-1}$ gives the short-term relationship.

The value p, for the number of lags, can be chosen based on the Schwartz and Akaike criteria. The normalized co-integrated vector, $(1, - \beta_2)\ Y_{it} = y_{1t} - \beta_2\ y_{2t}$, gives the long-term linear relationship between the two variables. This implies that, at equilibrium, $y_{1t} = \beta_2\ y_{2t}$. The elements of the α column vector give the speed by which the change in the dependent variables returns to the equilibrium value when deviations from equilibrium occur. This is given by the following equations:

$$D\_y_{1t} = \alpha_1 (y_{1t-1} - \beta_2 y_{2t-1}) \quad (2)$$

$$D\_y_{2t} = \alpha_2 (y_{1t-1} - \beta_2 y_{2t-1}) \quad (3)$$

Multiplying both sides of (3) by β2 and subtracting the two equations, one arrives at the following relationship:

$$y_{1t} - \beta_2\ y_{2t} = (1 + \alpha_1 - \alpha_2\ \beta_2)\ (y_{1t-1} - \beta_2 y_{2t-1}) \quad (4)$$

The absolute value of $(1+\alpha'\beta)$ or Abs $(1 + \alpha_1 - \alpha_2\beta_2)$ must be less than 1 for the long run linear relationship, $(y_{1t} - \beta_2 y_{2t})$, to be stationary.

Granger Causality Test

The Granger causality test (Granger, 1969) is used to determine whether one time series can forecast or predict another. The idea of forecasting or prediction is more relevant than testing whether Y causes or Granger-causes X, as is commonly asserted in the literature. According to *Diebold (2007) and Leame (1985), t*he term "causality" is a misnomer

The Granger test for two stationary time series, y, and x, involves regressing y on its own lags and the lags of x. One accepts the null hypothesis that *x* does not predict *y* if no lagged values of *x* are significant in the linear regression. Likewise, one can regress x on its own lags and the lags of y. In this case, y does not predict x if no lagged values of y are significant in the regression.

RESULTS AND DISCUSSION

Results of the Johansen co-integration analysis are presented in Table 1. From the trace test, it is seen that each pair of variables is integrated with one co-integration factor (r=1). If one considers the series Dow and GDP, one finds that the null hypothesis that there is zero integration vector (r =0) is rejected since the observed trace statistic of 50.02 is larger than the 5% level critical value of 19.99. The null hypothesis that there is one co-integration vector (r=1) is accepted since the trace statistics of 3.52 is less than the critical value of 9.13.

The test result for Dow and GDP is the same for all the other pairs of time series, showing that the time series are co-integrated with only one co-integration vector, as expected.

Estimates of α_1, α_2, β_2 and the long-term linear relation (y_{1t} - β_2 y_{2t}) from the VECM (1) in equation (1) are presented in Table 2. The estimate β_2 is positive, according to expectation, since the two variables under consideration move together in a common trend ($y_{1t} = \beta_2 y_{2t}$). Also, it is seen that the Abs ($1 + \alpha_1 - \alpha_2\beta_2$) < 1, which indicates that the long-term linear relationship or equilibrium between the two series under consideration is stationary, as expected. The estimates α_1 and α_2 in Equations (2) and (3) are small in magnitude, which shows that the time series return slowly to their equilibrium value when deviations from equilibrium occur.

Table 3 presents the co-integration results for the same series in Table 2, but for the period after 2007-Q4. This period is characterized by stock market volatility. It is interesting to see that the same co-integrated relationships still hold for this period. The equilibrium relationships are also stationary as indicated by the fact that Abs ($1 + \alpha_1 - \alpha_2\beta_2$) < 1. It is interesting to note, however, that the estimates of α_1 and α_2 are larger than those in Table 2. This implies that the speed of return to equilibrium is faster for this period. Also, Abs ($1 + \alpha_1 - \alpha_2\beta_2$) is smaller than that of Table 2.

Table 4 presents the short-term Granger analysis for each pair of variables. Associated with each of the tests, are the short-term results from the VECM (1) in Equation (1). For the sake of space, we present only the significant short-term relationships between two variables from the vector error correction model involving one co-integration vector, VECM (1)

In what follows, it is seen that there is good agreement between the short-term Granger test results and the short-term VECM (1) results. Table 4 shows that Dow predicts or influences GDP, but GDP does not influence Dow. This is in agreement with the results in Table 5, showing that only Dow influences GDP. The effect was positive. The GDP effect on the Dow was not significant and, therefore, not presented.

There is a bilateral relationship between Dow and Savings (Table 4). This relationship is shown in Table 6, where Dow had a negative effect on Savings and Savings had a negative effect on Dow. Likewise, Dow predicts Debt, and Debt predicts Dow (Table 4). The VECM (1) results in Table 7 also show that Dow predicts Debt and Debt predicts Dow. The sign is negative for the first lags and positive for higher lags.

It is seen from Table 4 that SP predicts GDP, but GDP does not predict SP. This is similar to the results between GDP and Dow. Table 8 results from the VECM (1) analysis are in agreement by showing that SP has a positive effect on GDP, but GDP does not influence SP. The Granger test shows that Debt predicts SP, but SP does not predict Debt. The associated results from Table 9 also show that Debt predicts SP, but SP does not predict Debt. SP and Savings have bilateral relationships (Table 4). Results from the VECM (1) in Table 10 show that SP has a negative relationship with Savings, but Savings do not influence SP. Of interest, is the finding that SP predicts Dow (significance at the 10% level). However, Dow has no significant relationship with SP. Results from the VECM (1) analysis show that Dow and SP were not related. The Granger test shows that CPI predicts SP, but the reverse is not true. Results from Table 11 show that CPI has a negative relationship with SP. SP influences CPI but was not significant at the 5% level.

The relationships between GDP, Savings, and CPI from the Granger test are presented in Table 4 and the associated VECM (1) results in Tables 12 to 14. GDP and Debt have a bilateral relationship, as seen in Table 4. The VECM (1) results in Table 12 show that GDP predicts Debt and Debt predicts GDP. GDP has a negative effect on Debt and Debt has a negative effect for the first lag, The Granger test shows that GDP and Savings have dual relationships. Results from The VECM (1) analysis (Table 13) show that GDP has a negative effect on Savings and Savings a negative effect on GDP. The Granger test in Table 4 shows that CPI predicts GDP, but GDP does not predict CPI. Results from Table 14 confirm that CPI has a negative and significant effect on GDP, but GDP has no effect on CPI.

TABLE 1. CO-INTEGRATION RESULTS FOR PAIRS OF VARIABLES USING THE JOHANSEN TRACE TEST

Dow, GDP			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	50.02	19.99
1	1	3.52	9.13
Dow, savings			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	55.07	19.99
1	1	2.86	9.13
Dow, Debt			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	21.59	19.99
1	1	7.15	9.13
SP, GDP			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	27.69	19.99
1	1	4.02	9.13
SP, Debt			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	22.73	19.99
1	1	6.65	9.13
SP, Savings			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	26.36	19.99
1	1	3.36	9.13
SP, Dow			
H_0	H_1	Trace	Critical Value
Rank = r	Rank > r		
0	0	20.94	19.99
1	1	8.68	9.13

H_0 Rank = r	H_1 Rank > r	Trace	Critical Value
SP, CPI			
0	0	34.40	19.99
1	1	5.05	9.13
GDP, Debt			
0	0	39.77	19.99
1	1	3.74	9.13
GDP, Savings			
0	0	46.00	19.99
1	1	6.36	9.13
GDP, CPI			
0	0	46.83	19.99
1	1	8.23	9.13

TABLE 2. CO-INTEGRATED VARIABLES AND LONG-TERM EQUILIBRIUM RELATIONSHIPS FROM THE VECTOR ERROR CORRECTION MODEL. DATA USED WERE QUARTERLY OVER THE PERIOD 1970-Q1 TO 2018-Q1

Cointegrated variables	Linear combination of the two variables at equilibrium	Speed of adjustments ($\alpha 1$ and $\alpha 2$) to deviations from equilibrium	Abs $(1 + \alpha_1 - \alpha_2\beta_2) < 1$ for stationarity of the linear combination
Dow, GDP	Dow - 2.769 GDP	Dow: - 0.00837 = α_1 GDP: - 0.00196 = α_2	0.99705
Dow, Savings	Dow - 11.394 Savings	Dow: -0.01022 = α_1 Savings: -.0002988 = α_2	0.99318
Dow, Debt	Dow -3.02927 Debt	Dow: -0.01358 = α_1 Debt: -0.00282 = α_2	0.99496
SP, GDP	SP - 0.24487GDP	SP: - 0.01763 = α_1 GDP: - 0.02222 = α_2	0.98781
SP, Debt	SP - 0.28009 debt	SP: - 0.01458 = α_1 Debt: -0.04176 = α_2	0.99711
SP, Savings	SP – 0.58625Savings	Sp: -0.00574 = α_1 Savings: -0.00473 = α_2	0.99703
SP, Dow	Dow - 9.34154 SP	Dow: -0.06081= α_1 SP: 0.00267 = α_2	0.91425
SP, CPI	SP - 34.09574 CPI	SP: -0.01741 = α_1 CPI: 0.00002844 = α_2	0.98162
GDP, Debt	GDP - 0.38290 Debt	GDP: 0.00689 = α_1 Debt: 0.02755 = α_2	0.99634
GDP, Savings	GDP- 0.7449 Savings	GDP: 0.00120 = α_1 Savings: 0.00417 = α_2	0.99809
GDP, CPI	GDP - 332.92945 CPI	GDP: - 0.00274 = α_1 CPI: 0.00000441 = α_2	0.99579

TABLE 3. CO-INTEGRATED VARIABLES AND LONG-TERM EQUILIBRIUM RELATIONSHIPS FROM THE VECTOR ERROR CORRECTION MODEL. DATA USED WAS QUARTERLY OVER THE PERIOD 2008-Q1 TO 2018-Q1

Cointegration 2008-Q1 to 2018-Q1	Linear combination of the two variables at equilibrium	Speed of adjustments (α1 and α2) to deviations from equilibrium	Abs $(1 + \alpha_1 - \alpha_2\beta_2) < 1$ for stationarity of the linear combination
Dow, debt	Dow -1.41828 Debt	Dow: $0.06617 = \alpha_1$ Debt: $0.10592 = \alpha_2$	0.91594
Dow, GDP	Dow -2.54749 GDP	Dow: $-0.38014 = \alpha_1$ GDP: $-0.04038 = \alpha_2$	0.72272
Dow, Savings	Dow -2.21914 Savings	Dow: $-0.08912 = \alpha_1$ Savings: $-0.03328 = \alpha_2$	0.98473
SP, debt	SP - 0.26170 Debt	SP: $-0.13486 = \alpha_1$ Debt: $0.29947 = \alpha_2$	0.78677
SP, GDP	SP - 0.33218 GDP	SP: $-0.37957 = \alpha_1$ GDP: $-0.26819 = \alpha_2$	0.70952
SP, Savings	SP - 0.31962 Savings	SP: $-0.50364 = \alpha_1$ Savings: $-0.07324 = \alpha_2$	0.51977
SP, Dow	SP - 0.12516 Dow	SP: $-0.36586 = \alpha_1$ Dow: $-1.35342 = \alpha_2$	0.80353
SP, CPI	SP -132.48593 CPI	SP: $-0.12667 = \alpha_1$ CPI: $0.00020369 = \alpha_2$	0.84635
GDP, Debt	GDP --1.41828 Debt	GDP: $0.06617 = \alpha_1$ Debt: $0.10592 = \alpha_2$	0.91594
GDP, Savings	GDP -1.22919 Savings	GDP: $-0.20875 = \alpha_1$ Savings: $-0.02276 = \alpha_2$	0.81922
GDP, CPI	GDP -479.28654 CPI	GDP: $-0.04059 = \alpha_1$ CPI: $0.00018366 = \alpha_2$	0.87141

TABLE 4. GRANGER TESTS FOR PAIRS OF VARIABLES

	Chi-square	P > Chi-square
Dow predicts GDP	15.45	0.0015
GDP predicts Dow	2.23	0.5264
Dow predicts savings	12.06	0.0169
Savings predicts Dow	8.58	0.0726
Dow predicts Debt	11.14	0.0486
Debt predicts Dow	25.36	0.0001
SP predicts GDP	16.31	0.0060
GDP predicts SP	3.65	0.6014
SP predicts Debt	8.71	0.1213
Debt predicts SP	29.00	0.0001
SP predicts savings	12.94	0.0116
Savings predicts SP	10.08	0.0391
SP predicts Dow	7.83	0.0978
Dow predicts SP	6.66	0.1552
SP predicts CPI	6.84	0.2327
CPI predicts SP	22.79	0.0004
GDP predicts Debt	25.67	0.0023
Debt predicts GDP	38.89	0.0001
GDP predicts savings	21.05	0.0003
Savings predicts GDP	27.28	0.0001
GDP predicts CPI	3.36	0.3391
CPI predicts GDP	8.37	0.0389

TABLE 5. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN DOW AND GDP. D REFERS TO THE FIRST DIFFERENCE

Dependent	Estimate	Std. Error	T Ratio	Prob>|T|
D_GDP(t):				
Independent variables:				
D_Dow(t-1)	0.03119	0.00930	3.35	0.0010
D_GDP(t-1)	0.23023	0.07808	2.95	0.0036
D_Dow(t-2)	0.02369	0.00963	2.46	0.0148

TABLE 6. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN DOW AND SAVINGS. D REFERS TO THE FIRST DIFFERENCE

Dependent		Estimate	Std. Error	T Ratio	Prob>|T|
D_Dow(t)	Independent:				
	D_Dow(t-1)	0.17072	0.07613	2.24	0.0262
	D_Sav(t-1)	-2.22536	1.32454	-1.68	0.0947
	D_Dow(t-3)	0.14063	0.07611	1.85	0.0663
D_Savings(t)					
	D_Dow(t-1)	-0.01471	0.00397	-3.70	0.0003
	D_Sav(t-1)	0.38474	0.06907	5.57	0.0001
	D_Sav(t-3)	0.41316	0.07376	5.60	0.0001

TABLE 7. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN DOW AND DEBT. D REFERS TO THE FIRST DIFFERENCE

Dependent		Estimate	Std. Error	T Ratio	Prob>|T|
D_Dow(t)	Independent				
	D_Dow(t-1)	0.14868	0.07937	1.87	0.0627
	D_Debt(t-1)	-0.67349	0.39239	-1.72	0.0878
	D_Debt(t-2)	1.26685	0.38845	3.26	0.0013
	D_Dow (t-3)	0.13161	0.08041	1.64	0.1035
D_Debt(t)					
	D_Dow(t-1)	-0.03731	0.01658	-2.25	0.0257
	D_Debt(t-1)	0.27279	0.08196	3.33	0.0011
	D_Debt(t-2)	-0.15220	0.08114	-1.88	0.0623
	D_Debt(t-3)	0.22418	0.08440	2.66	0.0086
	D_Dow(t-4)	0.03276	0.01692	1.94	0.0544
	D_Debt(t-4)	0.29264	0.08477	3.45	0.0007

TABLE 8. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN SP AND GDP. D REFERS TO THE FIRST DIFFERENCE

Dependent		Estimate	Std. Error	T Ratio	Prob>|T|
D_GDP(t)	Independent				
	D_GDP(t-1)	0.24260	0.08022	3.02	0.0029
	D_SP(t-1)	0.21318	0.08289	2.57	0.0109
	D_SP(t-2)	0.21946	0.08425	2.60	0.0099
D_SP(t)					
	D_SP(t-1)	0.14739	0.08456	1.74	0.0830

TABLE 9. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN SP AND DEBT. D REFERS TO THE FIRST DIFFERENCE

Dependent		Estimate	Std. Error	T Ratio	Prob>|T|
D_Debt(t)	Independent				
	D_Debt(t-1)	0.30005	0.08118	3.70	0.0003
	D_Deb(t-2)	-0.15910	0.08229	-1.93	0.0547
D_SP(t)					
	D_Debt(t-1)	-0.00012716	0.00004137	-3.07	0.0024
	D_Debt(t-2)	0.00012787	0.00004193	3.05	0.0026
	D_SP(t-2)	0.13108	0.07559	1.73	0.0846

TABLE 10. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN SP AND SAVINGS. D REFERS TO THE FIRST DIFFERENCE

Dependent	Independent	Estimate	Std Error	T Ratio	Prob>|T|
D_SP(t)					
	D_SP(t-1)	0.15980	0.07314	2.18	0.0302
	D_SP(t-3)	0.19168	0.07278	2.63	0.0092
D_Savings(t)					
	D_SP(t-1)	-0.11322	0.03394	-3.34	0.0010
	D_Sav(t-1)	0.41592	0.06845	6.08	0.0001
	D_Sav(t-3)	0.41606	0.07218	5.76	0.0001

TABLE 11. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN SP AND CPI. D REFERS TO THE FIRST DIFFERENCE

Dependent	Independent	Estimate	Std. Error	T Ratio	Prob>|T|
D_SP(t)					
	D_SP(t-1)	0.13634	0.07652	1.78	0.0765
	D_CPI(t-2)	-25.72336	11.83715	-2.17	0.0311
	D_SP(t-3)	0.26281	0.07464	3.52	0.0005
	D_CPI(t-3)	-28.84649	11.93745	-2.42	0.0167
D_CPI(t)					
	D_CPI(t-1)	0.34898	0.07478	4.67	0.0001
	D_SP(t-3)	0.00087916	0.00049544	1.77	0.0777

TABLE 12. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN GDP AND DEBT. D REFERS TO THE FIRST DIFFERENCE

Dependent	Independent	Estimate	Std. Error	T Ratio	Prob>|T|
D_GDP(t)					
	D_GDP(t-1)	0.28579	0.07880	3.63	0.0004
	D_Deb(t-1)	-0.19035	0.05211	-3.65	0.0003
	D_GDP(t-2)	0.21177	0.08165	2.59	0.0103
	D_Deb(t-2)	0.10744	0.05132	2.09	0.0378
D_Debt(t)					
	D_Deb(t-1)	0.14413	0.08440	1.71	0.0896
	D_GDP(t-2)	-0.43853	0.13225	-3.32	0.0011
	D_Deb(t-2)	-0.16349	0.08313	-1.97	0.0509
	D_GDP(t-3)	-0.28188	0.13837	-2.04	0.0432

TABLE 13. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN GDP AND SAVINGS. D REFERS TO THE FIRST DIFFERENCE

Dependent	Independent	Estimate	Std. Error	T Ratio	Prob>|T|
D_GDP(t)					
	D_GDP(t-1)	0.35229	0.07136	4.94	0.0001
	D_Sav(t-1)	-0.34288	0.15617	-2.20	0.0294
	D_Sav(t-3)	0.40930	0.15406	2.66	0.0086
D_Savings(t)					
	D_GDP(t-1)	-0.15033	0.03054	-4.92	0.0001
	D_Sav(t-1)	0.33380	0.06685	4.99	0.0001
	D_Sav(t-3)	0.40638	0.06594	6.16	0.0001

TABLE 14. THE SHORT-TERM SIGNIFICANT RELATIONSHIP, FROM THE VECM (1), BETWEEN GDP AND CPI. D REFERS TO THE FIRST DIFFERENCE

Dependent	Independent	Estimate	Std. Error	T Ratio	Prob>|T|
D_GDP(t)					
	D_GDP(t-1)	0.40266	0.08009	5.03	0.0001
	D_GDP(t-2)	0.26628	0.08078	3.30	0.0012
	D_CPI(t-2)	-25.55167	12.09604	-2.11	0.0361
D_CPI(t)					
	D_CPI(t-1)	0.30063	0.08207	3.66	0.0003

CONCLUSION

In this study, we investigated co-integration and long-term relationships between macroeconomic time series using the Johansen test and the Johansen Vector Error Correction Model (VECM). Also, short-term relationships between time series were determined from the Granger test and the VECM (1). Results showed that the Dow index was co-integrated with GDP, debt, S&P 500 index, and savings deposits. The S&P 500 index was co-integrated with Dow, GDP, debt, savings deposits, and CPI. GDP was co-integrated with CPI, savings deposits, debt, S&P 500, and Dow.

Inflation, debt, and savings deposits were the macroeconomic variables co-integrated with Dow, S&P 500, and GDP. The long-term linear relationships at equilibrium between the variables were of the form ($Y_{1t} - \beta_2 Y_{2t}$). The error correction rates for deviations from the long-term equilibrium were small in magnitude, less than 4% per quarter. This was for the period from 1970-Q1 to 2018-Q1.

For the period from 2008Q1 to 2018Q1, where the stock market showed considerable volatility, the error correction rates were considerably higher, with the highest being 50%.

Using the Granger test and the VECM (1), the short-term relationship showed that Dow and debt had a bilateral relationship. Dow and savings deposits also had a bilateral relationship.

Dow had a positive effect on GDP, but GDP did not affect Dow.

SP had a bilateral relationship with savings deposits. SP had an effect on GDP. Debt and CPI had an effect on SP. There was no significant relationship at the 5% level between SP and Dow.

GDP had a bilateral relationship with debt and with savings deposits. Inflation had a negative effect on GDP, but GDP did not affect inflation.

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