INFLUENCES OF MONEY SUPPLY AND OIL PRICE ON U.S. STOCK MARKET

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ABSTRACT

This paper studies the long-run and short-run dynamic effects of broad money supply (M_2) and oil price on U.S. stock market (S&P500). Monthly data are employed from January, 1974 through April, 2006. Each variable is nonstationary in level with I(1) behavior. The above three variables depict a cointegrating relationship. The vector error-correction models do not reveal any converging long-run causal flows, although short-run interactive feedback relationships exist. The current volatility of U.S. stock market is fueled by its past volatilities. Negative monetary and oil shocks initially depress the U.S. stock market.

Keywords: Cointegration, Oil Price, Money Supply, Stock Market

JEL Classification: C32, E32

I. INTRODUCTION

Oil is a key input for manufacturing output. Surges in oil prices translate into higher manufacturing costs. Rising production costs generate cost-push inflation in the economy, taking a toll on corporate profits in a highly competitive market environment wherein corporations lose pricing power. Also, an oil price increase acts like an inflation tax on consumption, reducing the amount of disposable income for consumers. These effects reduce company wealth, lowering their dividends (Rogoff, 2006). Studying the U.S., Canadian, Japanese and U.K. stock markets, Jones and Kaul (1996), show that all the markets respond negatively to oil shocks.

The primary objective of the U.S. monetary policy is to maintain price stability with sustainable maximum economic growth. In anticipation of higher inflation following oil price surges, the Federal Reserve raises short-term interest rate thereby to reduce money supply. Conversely, the Federal Reserve reduces short-term interest rate to inject additional money into the economy in apprehension of unleashing recessionary forces. The stock markets usually respond negatively to interest rate increases and positively to interest rate decreases. The effect of changes in money supply on stock returns has been a matter of controversy among economists for many decades. Those who favor the linkages between money market and stock market argue that a wealth effect due to a change in money supply disturbs the equilibrium in the portfolio of investors. Readjustments in asset portfolio establish a new equilibrium inducing changes in asset prices. On the other hand, those who believe in stock market efficiency find no causal connections between changes in money supply and stock prices as stock market would already have incorporated all the current and anticipated changes in money supply. Moreover, if the change in money supply coincides with a corresponding change in the velocity of money, it will not have any effect on stock prices. Sprinkel (1964) found a strong relationship between U.S. stock prices and money supply using data from 1918 through 1960. Rozeff (1974) concluded that U.S. stock market is efficient with respect to monetary policy. Similarly, Kraft and Kraft (1977) found no causal relationship between U.S. money supply and stock returns.

The focus of this paper on oil price and money supply is motivated by their relationship with the macroeconomy and the stock markets. Understanding of such relationship is of great importance for financial hedgers, portfolio managers, asset allocators and financial analysts. This is also important for the formulation of U.S. monetary policy. The recent crude oil price surges reaching new historic highs in 2008 coupled with housing meltdown and credit crunch amid persistent signs of trouble in the stock market and further rate cuts by the Federal Reserve to forestall future slide of the economy into recession has renewed interest in this topic.

This paper thus investigates empirically the dynamic effects of changes in broad money supply and oil price on the overall U.S. stock market (S&P 500). The S&P500 Index that incepted on March 1, 1957 today comprises almost 80% of the value of all U.S. stocks. Over $1 trillion is directly or indirectly tied to the performance of 500 firms included in this index. The changing composition of the index also mirrors larger changes in the economic landscape (Siegel and Schwartz, 2007). Some of the relatively recent advances in cointegration methodology are applied using monthly data from January, 1974 through April, 2006. Furthermore, variance decomposition and impulse response analyses are performed to gain some additional insights. The rest of the paper is organized as follows. Section II briefly reviews the related literature. Section III outlines the empirical methodology. Section IV reports results. Section V offers conclusions.

II. BRIEF REVIEW OF RELATED LITERATURE

Numerous macroeconomic, financial and demographic variables that influence stock markets have been documented in the recent empirical literature without a consensus on their appropriateness as regressors [Lanne (2002), Lewellen (2003), Campbell and Yogo (2003), Janson and Moreira (2004), Donaldson and Maddaloni (2002), Goyal (2004), and Ang and Maddaloni (2005)]. Frequently cited macroeconomic variables are GDP growth, industrial production rate, short-term interest rate, inflation rate, interest rate spread, exchange rate, current account balance, unemployment rate, fiscal balance, etc. A limited number of empirical studies has been conducted investigating the direct effects of changes in monetary aggregates and oil price on the U.S. stock market, although they influence the stock market through indirect channels via inflation rate, interest rate and GDP growth.

The rationale for the relationship between the money supply and stock price is that monetary disturbance resulting from excess supply of money leads to an increase in expenditure on goods as well as other financial assets, including stocks [Rozeff (1974), Moosa(1998), Fama (1981), Malliaris and Urruita (1991)]. To the degree that excess liquidity influences the stock market, the impact of the change in monetary policy is relatively quick and direct. Monetary expansion reduces short-term interest rate as far as the liquidity effect dominates the combined expected price effect and income effect. This, in turn, bolsters stock market as stock prices and interest rates should be negatively correlated. Higher interest rates resulting from contractionary monetary policy are usually bad for stock markets because they (a) reduce the value of equity as stipulated by the dividend discount model, (b) make fixed income securities more attractive as an alternative to holding stocks, (c) may reduce the propensity of investors to borrow and invest in stocks, and (d) raise the cost of doing business and hence affect profit margins. The opposites also apply for monetary expansion.

The number of papers investigating the linkages between oil prices and stock markets is relatively scant. If oil affects real output, increases in oil price depress aggregate stock price by lowering expected earnings. This suggests that oil prices should be associated with stock returns. In other words, oil price movements do indeed affect U.S. stock returns [Kaul and Jones (1996), Sadorsky (1999), Giner (2001)]. Huang, Masulis, and Stoll (1996) investigate the impact of oil price shocks on the U.S. stock market from a financial markets perspective. They find evidence for significant Granger causality from oil futures to stocks of individual oil companies and find evidence for no direct impact on the S&P 500. Nonlinear linkages between oil prices and the stock markets are uncovered by [Mork (1989), Hamilton (1996, 2000), Balke, Brown and Yucel (1999), Mork, Olsen, and Mysen (1994), Hiemstra and Jones (1994), Faff and Brailsford (2000), Ciner (2001)].

Hamilton (1983) shows that almost all U.S. recessions since the Second World War have been preceded by oil shocks. Mork (1994) surveys the extensive literature on oil and the macroeconomy and demonstrates a clear negative correlation between oil prices and aggregate measures of output or employment. Furthermore, stock markets being rational fully adjust to the impact of oil shocks on dividends.

III. METHODOLOGY

First, the standard descriptors (mean, standard deviation, skewness and Kurtosis) are used to examine the likely distribution of data on each variable. Second, the modified DF (Dickey-Fuller) test, and the modified Ng-Perron test are applied for unit root (nonstationarity) following Elliot et al, (1996), and Ng and Perron (2001) respectively. Their counterpart (the KPSS) test for no unit root (stationarity) is also applied following Kwiatkowski, et al., (1992). Third, on the evidence of data nonstationarity, the order of integration of each variable is ascertained by the first or higher order differencing of the level data since all variables must be of the same order of integration to be cointegrated (Engle and Granger, 1987) revealing I(1) or I(d) behavior. Fourth, λ_{trace} and λ_{max} tests are implemented to search for cointegrating (long-run equilibrium) relationship among the variables, as outlined by [Johansen (1988, 1991) and Johansen and Juselius (1990, 1992)]. Finally, relevant vector error-correction models are estimated to capture the long-run and the short-run causal dynamics in terms of interactive feedbacks (lead-lag relationships) among the variables.

As the unit root tests have now become fairly standard, they do not require further elaborations. The cointegration procedure, as developed in Johansen (1988) and Johansen and Juselius (1990, 1992), allows interactions in the determination of the relevant economic variables and is independent of the choice of the endogenous variable. Most importantly, it allows explicit hypotheses tests of parameter estimates and rank restrictions using likelihood ratio tests. The empirical exposition of the Johansen and Juselius methodology is outlined as follows:

$$\Delta V_t = \tau + \Omega V_{t-1} + \sum_{i=1}^{k-1} \Omega_j \Delta V_{t-j} + m_t$$

where Vt denotes a vector of S&P 500, broad money supply (M_2) and oil price while $\Omega = \alpha\beta'$. Here, α is the speed of adjustment matrix and β is the cointegration matrix. The above equation is subject to the condition that Ω is less than full rank matrix, i.e., $r < n$. This procedure applies the maximum eigenvalue test (λ_{max}) and the trace test (λ_{trace}) for null hypotheses on r. Of these two tests, λ_{max} test is expected to offer a more reliable inference as compared to λ_{trace} test (Johansen and Juselius (1990)). However, the Johansen and Juselius test procedure suffers from its sensitivity to the selection of the lag structures.

This study estimates the following equations to retrieve the error-terms for subsequent uses in the respective vector error-correction models:

$S\&P500\ (t) = a + bM_2(t)+cOil\ Price\ (t) + e_t$…….(1)

$M_2\ (t) = a' + b'S\&P500(t)+c'Oil\ Price\ (t) + e'_t$…….(2)

$Oil\ Price\ (t) = a' + b''S\&P500(t)+c''\ M_2\ (t) + e''_t$…….(3)

The above trivariate system of OLS regressions are considered for possible bidirectional causal relationship among above three variables.

Next, on the evidence of data nonstationarity and I(1) behavior, the corresponding vector error-correction models are estimated. The relevant vector error-correction models are specified as follows:

$$\Delta S\&P500(t) = \alpha e_{t-1} + \sum_{i=1}^{m} \beta_i \Delta S\&P500(t-i) + \sum_{i=1}^{n} \psi_i \Delta M_2(t-i) + \sum_{i=1}^{k} \Pi_i \Delta Oil\ Price(t-i) + \varepsilon_t \ldots(4)$$

$$\Delta M_2(t) = \alpha' e'_{t-1} + \sum_{i=1}^{m} \beta'_i\ \Delta M_2(t-i) + \sum_{i=1}^{n} \psi'_i\ \Delta S\&P500(t-i) + \sum_{i=1}^{k} \Pi'_i\ \Delta Oil\ Price(t-i) + \varepsilon'_t \ldots.(5)$$

$$\Delta Oil\ Price(t) = \alpha'' e''_{t-1} + \sum_{i=1}^{m} \beta''_i\ \Delta Oil\ Price(t-i) + \sum_{i=1}^{n} \psi''_i\ \Delta S\&P500(t-i) + \sum_{i=1}^{k} \Pi''_i\ \Delta M_2(t-i) + \varepsilon''_t \ldots.(6)$$

The negative sign of the error-correction terms and their statistical significance indicate converging long-run equilibrium relationship and long-run causal flows from independent variables to the dependent variable of each equation. The remaining terms in first-differences (Δ) capture the short-run dynamics. Akaike Information Criterion (Akaike, 1969) is invoked to determine the optimum lag-structure to overcome the problems of overparameterization and underparameterization that are likely to induce bias and inefficiency into the estimated parameters.

Finally, variance decomposition and impulse response analyses are performed. Monthly data are utilized from January, 1974 through April, 2006. This sample period is important for a fascinating history of oil price movements. The data on stock market index (S&P500) have been obtained from WWW.Yahoo Finance. Oil price data are collected from Energy Information Administration website. Money supply data on M_2 are obtained from Economic Time Series Page of the Federal Reserve Bank of St. Louis. The level data are employed without transformations to obtain a real picture.

IV. RESULTS

To have a glimpse of the nature of the data distribution, descriptive statistics are presented below:

Table 1
Descriptive Statistics

Series	*Mean*	*STDEV*	*Skewness*	*Kurtosis*	*Jaraque-Bera*
M_2	3209.649	1627.51	0.480352	2.343513	21.88849
Oil Price	19.45874	10.37203	1.480749	5.903537	278.0828
S&P 500	509.0838	436.2056	0.792527	2.142157	52.51401

As observed in Table 1, the distribution of each variable is slightly skewed to the right while the distribution of oil price has higher positive skewness. There is no evidence of excess kurtosis excepting oil price. The Jarque-Bera statistics also indicate near-normal distribution with an exception of oil price. This confirms some volatile behavior in oil price movements over the sample period with frequent drifts and spikes.

Table 2
Correlation Matrix

	M_2	***Oil Price***	***S&P500***
M_2	1.000000		
Oil Price	0.583624	1.000000	
S&P500	0.902308	0.440433	1.000000

Table 2 displays the results from the Pearson correlation procedure. The correlation coefficient between M_2 and Oil Price is 0.583624. The correlation coefficient between Oil Price and S&P500 is 0.440433 while that between M_2 and S&P500 is 0.902308.

The time series property of each variable is examined by implementing the modified DF, modified Ng-Perron and KPSS tests as shown below:

Table 3
Modified Dickey-Fuller, Ng-Perron, and KPSS Tests*

Series	***Level***			***Differences***		
	DF-GLS	***Ng-Perron***	***KPSS***	***DF-GLS***	***Ng-Perron***	***KPSS***
M_2	0.44227	0.37113	0.371561	-7.203452	-5.88572	0.314972
Oil Price	2.17051	-1.01042	0.249353	-2.909924	-11.0445	0.171579
S&P500	-1.152863	-1.14553	0.330787	-20.50292	-9.83232	0.084983

* The modified Dickey-Fuller (DF-GLS) critical values are -2.653, -1.954 and -1.609 at 1%, 5% and 10% levels of significance respectively. The Modified Phillips-Perron (Ng-Perron) critical values are -13.80, -8.10 and -5.70 at 1%, 5% and 10% levels of significance respectively. The KPSS critical values are 0.739, 0.463 and 0.347 at 1%, 5% and 10% levels of significance respectively.

It can be observed in table 3 that variables are not stationary in levels at 1% and 5% levels of significance since their calculated values are less than their respective critical values. Each variable also depicts I(1) behavior. As all variables are nonstationary in levels with I(1) behavior, their cointegrating relationship is studied in terms of λ_{trace} and λ_{max} tests following the Johansen-Juselius procedures. The results are reported as follows:

Table 4
Johansen-Juselius Multivariate Cointegration Test Results
Series: M_2, Oil Price and S&P500

Panel A: Trace Test			
Hypothesized No. of CE(s)	***Trace Statistic(λ_{trace})***	***0.05 Critical Value***	***Prob*****
None*	47.02935	29.79707	0.0002
At most 1	3.473279	15.49471	0.9414
At most 2	0.000694	3.841466	0.9802
Panel B: Max-Eigenvalue Hypothesized No. of CE(s)	***Max-Eigen Statistic(λ_{max})***	***0.05 Critical Value***	***Prob*****
None*	47.02935	21.13162	0.0000
At most 1	3.473279	14.2646	0.9104
At most 2	0.000694	3.841466	0.9802

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**McnKinnon-Haug-Michelis (1999) p-values

Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 4 [Panels (A) and (B)] reveal respectively that both λ_{trace} and λ_{max} tests indicate at least one cointegrating relationship among the variables at 5% level of significance. In other words, S&P500, M_2 and Oil Price are cointegrated at 95% confidence, and at least one factor drives such relationship toward long-run convergence. This inference is based on the evidence that the calculated values of the λ_{trace} and the λ_{max} statistics are larger than their respective critical values in the first case of each panel of the above table. Thus, the null hypothesis of no cointegration is clearly rejected at 5% significance level in each panel.

Consequently, the vector error-correction models of equations (4), (5) and (6) are estimated. The results are as follows:

Table 5
Vector Error-Correction Models

Dependent Variables	*Error-Correction Terms*	*Independent Variables*		
		ΣΔS&P500	*ΣΔM_2*	*ΣΔ Oil Price*
ΔS&P500	0.003111 [0.67680]	0.945396		
Δ M_2	0.012951*** [6.34690]		19.29639	
ΔOil Price	5.40E-04** [2.36914]			11.49752

*** and ** indicate level of significance at the 1 and 5 percent, respectively.

In Table 5, there is no evidence of long-run converging causal flow from the independent variables to the relevant dependent variable as none of the coefficients of the error-correction terms has expected negative sign. In contrast, the coefficient of each error-correction term is positive. However, each coefficient is highly insignificant as reflected in the associated t-value within parenthesis. But short-run feedback relationships among the variables are in existence.

As the principal focus of this paper is on the effects of broad money supply and oil price on the U.S. stock market, the results for variance decomposition analysis of S&P 500 are shown below.

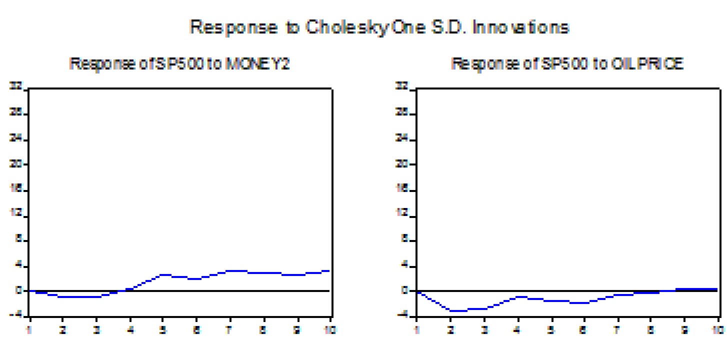
Table 6
Variance Decomposition of S&P500

Period	*S.E.*	*S&P500*	*M_2*	*OILPRICE*
1	29.06295	100.0000	0.000000	0.000000
2	40.33707	99.34319	0.027722	0.629083
3	48.37716	99.20915	0.047960	0.742889
4	55.27120	99.26444	0.076177	0.659381
5	61.43169	99.31061	0.103748	0.585638
6	67.05893	99.33434	0.126571	0.539086
7	72.26608	99.34770	0.144177	0.508124
8	77.13051	99.35795	0.158112	0.483942
9	81.71175	99.36699	0.169502	0.463505
10	86.05571	99.37496	0.179028	0.446008
11	90.19701	99.38195	0.187113	0.430938
12	94.16231	99.38817	0.194069	0.417764

The results in Table 6 show that variance of S&P500 is caused mostly by itself. Over time, its own causation diminishes marginally while the causations by M_2 and Oil price rise slightly. But the contributions of M_2 and oil price to the U.S. stock market volatility are not statistically significant.

The impulse response analysis indicates the effects of a given shock by one standard deviation (+-2 S.E innovation) in M_2 and Oil Price on S&P500. The following graphs display the responses of S&P 500 to the shock given to M_2 and Oil Price:

Figure 1



(A) (B)

Figure 1(A) shows that a negative monetary shock initially depresses S&P500 in small magnitudes for a period of 3 months. Afterwards, the stock market gains momentum persisting beyond next 6 to 7 months. Figure 1(B) shows that a negative oil price shock depresses S&P500 for a period extending over 7 months. Thereafter, the stock market recovers from a negative territory and reaches a neutral territory.

V. CONCLUSION

The U.S. stock market (S&P500), broad money supply (M_2) and oil price are nonstationary at 1% and 5% levels of significance as uniformly confirmed by the modified DF, modified Ng-Perron and KPSS tests depicting I(1) behavior. Both λ_{trace} and λ_{max} tests reveal at least one cointegrating relationship among the variables at 95% confidence. The estimates of vector error-correction models show that broad money supply (M_2) and oil price unleash no long-run converging causal effects on U.S. stock market. However, there is evidence of short-run causal flows from these variables to stock market in Granger sense. Since the principal focus of this study is on the effects of the changes in oil price and broad money supply on the U.S. stock market, they matter in the short run and not in the long-run. Thus, equity investors with short planning horizon should pay close attention to the developments in the U.S. monetary policy and the oil futures market. The investors with long planning horizon need not be overly concerned about these developments. These findings have implications for financial hedgers, portfolio managers, asset allocators and other financial analysts.

The variance decomposition analysis shows that the current market volatility feeds on itself from its past volatilities. The impulse response analyses confirm initial depressing effects on U.S. stock market emanating from negative monetary and oil shocks.

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