Cointegration and Granger Causality between Stock Market Returns and Macroeconomic Factors: Evidence from Canada

by

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Major paper presented to the

Department of Economics of the University of Ottawa

in partial fulfillment of the requirements of the M.A. Degree

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Ottawa, Ontario

Sept, 2003

1. INTRODUCTION

Prices in the stock market represent the market value of claims against current and future economic output, so the valuation of stock market prices may reflect some systematic forces or fundamental factors determining the state of the economy. A large theoretical and empirical literature studies the relationship between stock market prices and macroeconomic factors, such as GNP, inflation, the trade balance, government bonds, dividend yields, price-earnings ratios, the foreign exchange market, interest rates and international oil prices.

One strand of the economic and financial literature focuses on trying to explain asset price changes using events such as announcements of macroeconomic news or proxies for expected returns and future cash flows such as the growth rate of GNP. This work was pioneered by Chen et al. (1986), Cutler et al. (1989) and Fama (1990). Another strand of the literature that attempts to predict changes in real activity using a set of leading indicators, including Burns and Mitchell (1943) and Stock and Watson (1989), indicates that some financial variables, in particular default spreads and stock returns, lead turning points in real activity and capture future developments on the real side of the economy. According to Canova and Nicolo (1995), however, these two strands of the literature suffer from the same problem: they cannot clearly identify and examine the sources and mechanisms through which real economic activity influences asset price variability because they are just statistical exercises. In an attempt to solve this problem, Balvers et al. (1990) and Canova and Marrinan (1995) build explicit behavioural models to interpret moments of data and the predictability of excess returns in various domestic and international markets.

In response to these empirical studies, valuation models such as the discounted cash flow model (DCFM), the capital asset pricing model (CAPM), arbitrage pricing theory (APT), and the multi-factor pricing model have been developed to better illustrate the effects of internal and external factors that influence stock prices, returns and volatility.[1] More recently, accompanying the recent emergence of new capital markets and financial crises, the construction of valuation models for emerging stock markets under the assumption of imperfect markets has attracted more attention (e.g. Kwon and Shin 1999, Islam and Watanapalachaikul 2002, Cheung and Lai 1998).

The purpose of this paper is to investigate the long-run co-movement and causal relationship between a stock market price index and macroeconomic variables including real GNP, the industrial production index, the real exchange rate, the short-term interest rate, inflation, exports and the growth rate of the narrowly-defined money supply, using Canadian data. The advantage of using Canadian data is that the Canadian financial market is fully developed, ranking with the capital markets of such large countries as Germany and Japan after the US and UK in terms of being the best in the world. In addition, I will examine these relationships under fixed and flexible exchange rate regimes.

My analysis is based on a linear multi-factor model in which observable economic variables are considered to be proxies for extra market risk factors. In contrast to other authors like Kwon and Shin (1999), I use the US stock market price index (Standard and Poor's composite 500 index) as an international proxy for the influence of world markets. Because of the increasing integration of international financial markets a linkage between the US stock market and the Canadian stock market may be expected. Including the US stock market price index also helps to overcome the drawback of invalid long-run relationships and causality in an incomplete system mentioned by Caporale and Pittis (1997).

To accomplish these objectives, I apply two econometric techniques in this paper. The cointegration methodology allows me to explore the long-run relationship between stock

1. The Capital asset pricing model (CAPM) is an equilibrium theory of asset pricing, using a weighted average as the benchmark for calculating correlation, defining this benchmark as an index of the market-value-weighted portfolio of all possible risky investments. The arbitrage pricing theory (APT) is a multifactor equilibrium-pricing model, suggesting that macroeconomic variables may proxy for pervasive risk factors. For more details, see Harrington (1987).

market returns and macroeconomic variables. If macroeconomic variables are significantly and consistently priced in stock market returns, there will exist a common permanent component governing the long-term co-movements of the variables. The Granger causality technique tests the direction of causality and helps to shed light on the channels that link the variables. If the results show that the stock market causes the economic variables, stock price variability may be fundamentally linked to economic variables.

The paper is structured as follows. In section 2, I briefly review the relevant literature. In section 3, I explain the econometric procedures involved in the cointegration tests and the Granger causality tests to investigate the relationship between stock market returns and macroeconomic variables. Following the data description in section 4, in section 5 I apply the tests to Canadian data and further check how stock returns are influenced under different exchange rate regimes. Finally, section 6 concludes the paper.

2. LITERATURE REVIEW

During the past two decades, a number of empirical studies have used various methodologies and data series for different countries to explore the relationship between stock market prices and macroeconomic variables such as GNP, industrial production, the employment rate, inflation, the interest rate, the yield of corporate and government bonds, the trade balance, dividend yields, risk premiums, foreign exchange rates, oil prices, and the money supply (M1) (e.g. Pearce and Roley 1985, Chen et al. 1986, Fama 1990).The identification of the factors that determine asset prices is the first issue to consider. From a theoretical perspective, firstly, there seems to be a positive relationship between stock returns and real economic activities, like real GNP or industrial production and the employment rate, suggested by Chen et al. (1986) and Fama (1990). Because real economic activities will influence future internal and external aggregate demand that is reflected in expected future cash flows, the stock prices are affected in the same direction as a result.

Secondly, the theoretical relation between the exchange rate and stock returns is unclear. Furthermore, the nature of the change in stock prices would depend on the multinational characteristics of the firm. One interpretation of a negative relation between stock returns and the real exchange rate is that a change in exchange rates would affect a firm's foreign operations and overall profits, which in turn affect its stock prices. A positive relationship can be explained by the fact that changes in asset demands and supplies have an effect on the equilibrium exchange rate. An increase in domestic stock prices will increase money demand and interest rates. Higher interest rates will introduce more foreign capital, leading to an appreciation of the domestic currency and a rise in the real exchange rate.

Thirdly, the relation between interest rates and the stock price index is less clear, because it depends on the choice of interest rate to be studied. Changes in short-term and long-term interest rates may affect the discount rate and stock price as a result. Chen et al. (1986) found that stocks carry a negative risk-premium with respect to changes in long-term real interest rates. Fama (1990) used the term spread to forecast stock returns.[2] He found that the term spread has a business-cycle pattern, and thus can capture cyclical variation in expected returns, while Lee (1992) revealed that real stock returns cannot be explained significantly by interest rate.

Fourthly, relative price variability in the stock market is adversely affected by the expected and unexpected components of the rate of inflation (Fama 1981; Chen, Roll and Ross 1986). According to Fisherian theory, expected real returns are understood to be dependent on real factors and thus independent of the rate of inflation or the growth rate of money. Common stocks offer the best hedge against inflation.

Finally, stock prices may respond negatively to the unanticipated component of M1,

2. Term spread is the spread of long-term over short-term bond yields.

since the rate of inflation is positively related to money growth rates (Fama 1981). An increase in the money supply may lead to an increase in the discount rate. However, the negative effects on stock prices may be offset by a corporate earnings effect that would likely result in increased future cash flows and stock prices.

In the remainder of this section, I will discuss the relevant empirical work. From the perspective of efficient-market theory and capital asset pricing theory, Chen, Roll and Ross (1986) estimated a vector autoregressive (VAR) model involving US stock market returns and a set of economic state variable chosen as proxies for systemically influential risks: the spreads between long and short interest rates, expected and unexpected inflation, industrial production, the spread between high-and low-grade bonds, and oil prices.[3] The results demonstrated that NYSE returns are systematically affected and priced in accordance with the exposure to macroeconomic variables except oil prices, because the economic variables have an effect on expected cash flows and as a result on stock returns. They were the first to provide a foundation for the belief that there is a long-term equilibrium between stock prices and relevant macroeconomic variables.

Fama (1990) estimated a multiple linear regression model of real stock returns on real activities including the term spread, the dividend yield, the default spread and the production growth rate, using US data over the period from 1953 to 1987 to avoid the weak wartime relations between stock returns and real activity. The data consist of monthly, quarterly and yearly data. He found a strong relationship between stock returns and the future production growth rate. The regression's R^2 showed that 30% of the variance of annul NYSE value-weighted returns can be explained by the variables that proxy for expected returns and

3. Chen et al. (1986) defined the term spread as the difference between long-term government bonds at time t and treasury-bill rate at time t-1under the assumption of risk neutrality. They considered this variable as measuring the unanticipated return on long-term.

expected return shocks.[4] He also found that production growth as a proxy for shocks to expected cash flow captured 43% of the variance of annual returns. However, he did not explain why the combined explanatory power of the variables is less than the sum of their separate explanatory powers. Using an additional 65 years of data, Schwert (1990) employed the same linear regression tests as Fama (1990) to analyze the relationship between real stock returns and real activities, implementing the new Miron and Romer industrial production index and the old Federal Reserve Board industrial production index.[5,6] His results almost confirmed Fama's finding that real stock returns are highly correlated with the growth rate of future production and the variables that proxy for expected returns, regardless of the effect of the different definitions of the variables. He also revealed that stock prices are more closely related to the Fed's production growth rate than to the Miron-Romer production growth rate.

Canova and Nicolo (1995) used two types of regressions similar to those introduced by Fama (1990) and Schwert (1990) in order to examine the relationship between domestic output growth, stock returns and dividend yields using quarterly data for the period 1973-1991 for five different countries: the US, the UK, Germany, France and Italy. Their framework used two types of disturbances (exogenous government expenditure shocks and exogenous technology disturbances) and two sources of international interdependence (trade in intermediate goods and final consumption goods). They found that when government expenditure shocks drive the international cycle, the association between real GNP growth and stock returns is stronger because government expenditure shocks exert a strong positive effect on dividend yields. When technology shocks drive the cycle, the association is weaker because dividend yields are less correlated with GNP. Finally, they demonstrated that their

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4. He uses the regression R^2 to judge how much return variance is explained by information about real activity.
5. The Miron-Romer index of industrial production is a value-weighted average of indexes for 13 industrial products (iron, cola, petroleum, sugar, cattle, hogs, coke, flour, wool, coffee, tin, rubber, and silk). This index is not seasonally adjusted. The Federal Reserve Board index of industrial production is constructed in the same way as the Miron-Romer index, but it covers about 80 products in the 1919-1940 period.
6. The data include the monthly, quarterly and annual data.

model produces some important cross-country spillovers between stock returns and real activity.

Hardouvelis (1987) examined the extent of four stock price indices' reactions to the announcement of monetary (bank free reserves) and nonmonetary news (announcements of the trade deficit, the unemployment rate, and personal income).[7] The results of OLS estimation of a linear equation confirmed the *expected real interest rate hypothesis* and illustrated that stock prices are sensitive to monetary news. The stocks of financial companies are the most greatly affected.[8] Furthermore, he concluded that stock price reactions confirm the important role of the Federal Reserve in future macroeconomic developments.

Mukherjee and Naka (1995) carried out Johansen's cointegraton test based on a vector error correction model (VECM) to study the long-run dynamic linkage between the Japanese stock market and macroeconomic variables selected in light of "simple and intuitive financial theory" (Chen, Roll and Ross 1986): the exchange rate, the money supply, inflation, industrial production, the long-term government bond rate and the call money rate (short-term interest rate) using monthly data covering from 1971 to 1990. They found the presence of cointegrating vectors, indicating a long-term equilibrium in the system. Moreover, the signs of the estimated coefficients of the macroeconomic variables are identical to the hypothesized equilibrium relations and robust. The exchange rate, real activity, the money supply and the short-term interest rate respond positively to stock returns, while inflation and the long-term government bond rate respond negatively.

Based on a multivariate vector autoregressive model, Gjerde and Sattem (1999) performed Granger causality tests to analyze the causal relationship between stock returns

7. The four stock price indices are: the Standard and Poor 500 (large companies), the AMEX Major Market index (small companies), the Value Line index (small company stocks traded outside a major financial center), and the New York Stock Exchange Financial index (financial companies).
8. The expected real interest rate hypothesis claims that stock prices decrease because the real component of the nominal interest rate is expected to increase. This affects stock prices both directly because the real discount rate at which future cash flows are capitalized is expected to increase, and indirectly because real output is adversely affected by higher real interest rate and thus future cash flows are expected to decrease.

and macroeconomic variables in the small, open economy of Norway using monthly data for 1974 to 1994. They reported that Norwegian stock returns respond immediately, negatively to the short-term interest rate and inflation and positively to oil prices and real economic activities. They also found that the interest rate can explain a large fraction of the stock prices. However, they failed to identify a causal relation between stock returns and inflation.

At the micro level some studies focus on the exposure of domestic firms to foreign currency risk. Within the framework of arbitrage pricing theory, Jorion (1999) used a multi-factor model and a maximum-likelihood estimation procedure to examine the exchange rate exposure of US firms and the correlation between stock returns and fundamental factors such as the industrial production growth rate, inflation, risk premiums and the term structure. He replicated Chen, Roll and Ross (1986)'s results and found that the exposure of US common stocks to the exchange rate is not systemically related to expected returns, indicating that US investors seldom purchase compensation to avoid exchange risk. The joint F test indicated that significant cross-sectional variation in exposure to movements in the dollar is a characteristic of US industries.

Previous research has focused on well-developed economies, like the US, UK, and Japan, all considered to be efficient markets. However, accompanying the relaxation of foreign capital controls and the adoption of a more flexible exchange rate regime, the emerging stock markets have developed quickly, which opens the possibility of international investment and portfolio diversification but at the same time increases the volatility of foreign exchange markets and exposure to risk. Specifically, after the Asian financial crisis of the 1990s, issues related to the emerging stock market have attracted more attention. Using Johansen's cointegration test and Granger causality tests in a vector error correction model (VECM) model, Kwon and Shin (1999) found that a direct long-run equilibrium relationship exists between stock prices and macroeconomic variables such as the production index, the exchange rate, the trade balance, and the money supply in the Korean stock market. Furthermore, the Korean market is more sensitive to international trading activities than to inflation or short-term interest rate variables, in contrast to the US and UK. However, inconsistent with earlier findings that the stock market rationally signals changes in real activities (Fama 1990), their results indicated that the Korean stock price index is not a leading indicator for economic variables.

Islam and Watanapalachaikul (2002) provided a financial econometrics examination of stock valuations in the Thai stock market. Techniques such as unit root tests, cointegration tests, and the estimation of a multi-factor model are applied to identify the long-run linkages between macroeconomic variables and stock prices. The evidence revealed that a large fraction (98.7 percent) of the stock price could be explained by the significant factors -- the short-term interest rate, the foreign exchange rate, the bond rate, market capitalization, the price-earnings ratio and the CPI. Also employing a vector error correction model (VECM), Achsani and Strohe (2002) investigated causal relationships using the monthly data from 1990 to 2001 among the stock returns of Indonesia and macroeconomic variables including the international oil price. They found that the Jakarta Stock Exchange returns were positively related to economic activities (GDP and exports), international factors (the exchange rate) and monetary factors (M1). Particularly, monetary factors exert the most important effect on the behavior of the Jakarta stock market, followed by international factors and then the macroeconomic fundamentals in Indonesia.

In summary, given the results of the previous studies, firstly, I hypothesize that my study will show that there is a positive relationship between Canadian stock returns and real economic activities (proxied by GNP and the industrial production index) and a negative linkage between Canadian stock returns and inflation, while the relationships between stock returns and the growth rate of the money supply as well as the real exchange rate are an open question. Secondly, most of the studies focus on the US stock market, omitting research on the Canadian financial market, perhaps because the Canada economy is very tightly correlated with the US economy. Thirdly, recent applied econometric work demonstrates that the vector error correction model is more appropriate than the vector autoregressive model for analyzing the relationship between stock prices and macroeconomic variables, because the VECM can examine long-run dynamic co-movements. Since most authors use the VAR approach in the studies, their conclusions may be somewhat unreliable. Therefore, I will apply the VECM using quarterly data to examine the above-mentioned hypotheses and explore whether there exist long-run co-movements as well as short-run dynamics between Canadian stock returns and macroeconomic factors.

3. METHODOLGY

In this section, I will explain the econometric techniques used in my study. Based on the results of previous empirical studies, it is assumed that stock returns are linearly related to macroeconomic variables. I use cointegration tests to examine the long-run co-movements between stock returns and macroeconomic variables. Because cointegration analysis is appropriate only if variables are difference-stationary, the first step in the analysis is to pretest each variable to determine its order of integration. I use both the Elliott, Rothenberg and Stock (1996) DF-GLS test and the augmented Dickey-Fuller (ADF) unit root test to infer the order of cointegration (if any) in each of the variables. The subsequent step is to determine whether a group of non-stationary series is cointegrated by applying Johansen's cointegration tests to both the entire sample and two sub-samples. When the results of step two indicate that there is no cointegration, I estimate a VAR in first differences of the variables; otherwise, if the first-differences of each variable are stationary, I estimate a VECM. Finally, I perform the Granger causality test proposed by Dolado and Lukepohl (1996) to detect causal relations between stock returns and macroeconomic variables.

If macroeconomic variables are significantly and consistently priced in stock market returns, there will be a common permanent component governing the long-term co-movements of the variables. If there are no significant relations between macroeconomic variables and stock market returns, we can conclude that the Canadian stock market does not signal changes in real activity in Canada. This cointegrating relation between stock market prices and underlying factors is a necessary condition for equilibrium in models of the stock market. If the results show that the stock market causes and is caused by the economic variables, stock price variability may be fundamentally linked to economic variables.

3.1 Unit root test

3.1.1 Augmented Dickey-Fuller (ADF) Test

The ADF test makes a parametric correction for higher-order autocorrelation by adding lagged difference terms of the dependent variable y to the right-hand side of the regression:

$$\Delta y_t = \gamma \cdot y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \ldots + \delta_p \Delta y_{t-p} + \varepsilon_t \qquad (3.1.1)$$

This augmented specification is then used to test:

$$H_0: \gamma = 0, H_1: \gamma < 0$$

in this regression. Under the null hypothesis of a unit root, the asymptotic distribution of the t-statistic of γ is independent of the number of lagged first differences included in the ADF regression.[9] The critical values for the test depend on whether a constant or a constant and linear trend are included in the test equation.

3.1.2 Elliott, Rothenberg and Stock DF-GLS Test [10]

Elliott, Rothenberg and Stock (1996) constructed a modified univariate unit root test

9. See EViews 4.1 unit root tests introduction.
10. See EViews 4.1 manual: Elliott, Rothenberg and Stock DF-GLS unit root test introduction.

using GLS or quasi-differenced data, denoted as the DF-GLS unit root test. When an unknown mean or trend is present, the DF-GLS test shows a substantial improvement in size-adjusted power in finite samples relative to the ADF test.

Assume a quasi-difference of y_t that depends on the value a representing the specific point alternative against the null:

$$d\,(y_t|a) = \begin{cases} y_t & t=1 \\ y_t - ay_{t-1} & t>1 \end{cases} \quad . \tag{3.1.2}$$

Elliott, Rothenberg and Stock regress the quasi-differenced data $d\,(y_t|a)$ on the quasi-differenced $d\,(x_t|a)$:

$$d\,(x_t|a) = d(x_t|a)'\delta(a) + \eta_t \tag{3.1.3}$$

where x_t contains either a constant, or a constant and trend, η_t is a white noise disturbance and $\delta(a)$ contains the coefficients of $d(x_t|a)'$. Elliott, Rothenberg and Stock suggest setting $a=\bar{a}$, $\bar{a}$ =1-7/T if x_t= {1} (for the constant only case) and $\bar{a}$=1-13.5/T if x_t= {1, t} (for the constant and linear trend cases), where T is the number of observations.

The GLS detrended data, y_t^d, are defined using the estimates associated with the $\bar{a}$:

$$y_t^d \equiv y_t - x_t'\hat{\delta}(\bar{a}) \tag{3.1.4}$$

Then the DF-GLS test involves substituting the GLS detrended y_t^d for the original y_t to estimate the standard ADF test equation (3.1.1). The regression is given as:

$$\Delta y_t^d = ay_{t-1}^d + \beta_1 \Delta y_{t-1}^d + \dots \beta_p \Delta y_{t-p}^d + v_t \tag{3.1.5}$$

Since y_t^d is detrended, x_t is not included in the DF-GLS test equation.

The modified Akaike Information Criterion (MAIC) is used to choose the number of lag p, because Ng and Perron (2000) have shown that it provides the best combination of size and power in finite sample. While the DF-GLS t-ratio follows a Dicker-Fuller (no constant) distribution in the constant only case, the limiting distribution of the test statistics differs when both a constant and trend is included. EViews 4.1 uses critical value from the MacKinnon (1991) simulations for the constant only case, but uses the Elliott, Rothenberg and Stock (1996, 825) values for the constant and trend case.

3.2 Johansen's Cointegration Test

I employ VAR-based cointegration tests using the methodology developed by Johansen. If each variable is I (1), it is possible that they are cointegrated; that is, they may have a linear combination that is stationary. In this paper, Johansen's cointegration tests, which are described below, are employed to test for the presence of cointegration.

Consider a VAR of order p

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t, \qquad (3.2.1)$$

where y_t is a k-vector of non-stationary I (1) variables, x_t is a d-vector of deterministic variables, and ε_t is a vector of innovations. We can rewrite this VAR as

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t, \qquad (3.2.2)$$

where

$$\Pi = \sum_{i=1}^{p} A_i - I, \quad \Gamma_i = -\sum_{j=i+1}^{p} A_j .$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist $k*r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is I (0). r is the number of cointegrating relations (the rank) and each column of β is a cointegrating vector. The elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate the Π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of Π.

To determine the number of cointegrating relations r, I use the trace statistic, which is given by:

$$Q_r = -T\sum_{i=r-1}^{k}\ln(1-\hat{\lambda}_i), \tag{3.2.3}$$

where $\hat{\lambda}_i$ is the estimated value of the ith characteristic root of Π. The test is carried out sequentially beginning with $r = 0$ to $r = k\text{-}1$ until we cannot reject the null hypothesis that there are r cointegrating relations.

In addition, I use an alternative likelihood ratio test known as the maximum eigenvalue test, based on the statistic:

$$Q_{\max} = -T\ln(1-\hat{\lambda}_{r+1}), \tag{3.2.4}$$

In this test, the null hypothesis of the existence of r cointegrating vectors is tested against the alternative of r+1 cointegrating vectors. The critical values for Q_r and $Q_{\max}$ are provided by Osterwald-Lenum (1992).

Before carrying out the tests, the optimal lag length for the unrestricted VAR model is determined by the Akaike information Criterion (AIC). Following Reimers (1992), I modify Johansen's trace statistic by including a finite sample correction,

$$Q_r' = \frac{T-np}{T}Q_r \tag{3.2.5}$$

where T is the number of observations used to estimate the model, n is the number of variables included in the VAR system, and p is the number of lags in the VAR system.

3.3 Vector Error Correction Model (VECM)

A vector error correction model is a restricted VAR designed for modeling nonstationary series that are known to be cointegrated. I can use the VECM to study not only the long-term equilibrium behavior but also the short-run adjustment dynamics of time-series variables that are cointegrated. In terms of ability to explore dynamic co-movements among variables, the VECM is better than the standard vector autoregressive model.

The general form of a VECM is written as follows:

$$\Delta y_t = \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + a\beta \cdot y_{t-1} + \mu + \varepsilon_t \qquad (3.3.1)$$

where Δ denotes a first difference notation, y_t is a $k \times 1$ vector integrated of order one, μ is a $k \times 1$ constant vector representing a linear trend in a system, p is the number of lags, and ε_t is a $k \times 1$ Gaussian white noise residual vector. Γ_j is a $k \times k$ matrix and contains the short-run adjustments among variables across k equations at the jth lag. The matrix a is interpreted as the speed of adjustment and β denotes the cointegrating vectors. The parameters of the VECM are estimated using the maximum likelihood method proposed by Johansen.

3.4 Granger Causality Test

The presence of cointegration is consistent with a causal ordering in just one or in all possible directions; once it has been determined that a long-run relationship exists, it becomes relevant to determine the actual direction of causality. To explore the short-run dynamics between stock returns and macroeconomic variables, I employ the method for multivariate Granger Causality tests suggested by Dolado and Lutkepohl (1996). This test is computed from the multivariate least squares estimates of a VAR using the first p coefficient matrices. The virtues of their method are (1) the test statistic is easily computed and (2) one does not need know the cointegration properties of the system or the order of integration of the variables, which avoids possible biases. [11]

Letting $m = p + d_{MAX}$, the augmented VAR model can be written as

$$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_m y_{t-m} + \varepsilon_t \qquad (3.4.1)$$

11. This method does not require pre-testing for the unit root either.

To test the null hypothesis that a particular variable in y_t does not Granger cause another variable, one computes the Wald statistic for the testing the null hypothesis that the coefficients of the lagged values of the first variable in the equation for the second variable are jointly zero, including only the coefficients in $A_1,...,A_p$. I reject the null hypothesis of no Granger causality if the p-value is less than the level of significance.

If causality exists between stock returns and macroeconomic variables, it may be claimed that stock price variability is fundamentally linked to economic variables.

4. DATA

All the data used in this paper are quarterly and cover the period 1963 to 2001. Quarterly data was chosen because (1) limitations on the availability of higher-frequency data for some variables and (2) Fama (1990) found that the qualitative features of the relationship are not altered when using quarterly data rather than monthly data. Thus, quarterly data is sufficient for my paper. The Canadian stock market index used is the Toronto Stock Exchange (TSE) composite 300. This index is based solely on the 300 stocks with the largest float on the market, widely considered to be the benchmark for Canadian equities. The data are day closing prices.

The macroeconomic variables are selected according to Bank of Canada annual reports. They consist of real gross national product (GNP), the industrial production index (IP), exports of goods and service (EP), the change in the consumer price index as a proxy for inflation (INFL), the narrowly-defined money supply (M1), the real exchange rate (EXR), the term structure (IR), and Standard and Poor's 500 index (US).[12,13] Standard and Poor's index

12. M1 is defined as the growth rate of currency (bank notes and coins) in circulation plus personal chequing

represents the US equity market since it is a benchmark for well-diversified US investors.[14] For this variable also, the day closing price is used.

Following Phylaktis and Roavazzolo (2002), I use the real exchange rate instead of the nominal exchange rate because it reflects better the competitive position of an economy with the rest of the world. The real exchange rate is defined as domestic prices relative to foreign prices multiplied by the nominal exchange rate. The formula is expressed as:

$$EXR = \log CACPI - \log er - \log USCPI \tag{4.1}$$

where CACPI is the Canadian consumer price index, *er* is the spot exchange rate (in Canadian dollars per US) and USCPI is the US consumer price index.

The data are retrieved from Statistic Canada's CANSIM II database and the International Monetary Fund-*International Financial Statistics* CD-ROM. The Standard and Poor's index for the US is collected from the website of Robert J. Shiller. I have 156 observations for each variable. For some variables, the data retrieved are monthly, not quarterly. In theses cases, I converted the monthly data into quarterly data using EViews 4.1, which takes the quarterly average.

All the variables except the interest rate are transformed by taking the natural logarithm. The inflation rate and the growth rate of the money supply are computed by taking the first difference of the logs of the quarterly series (the Canadian consumer price index and the money supply).

In order to examine the effect of the exchange rate regime on stock returns, I divided the sample into two sub-periods: 1963 to 1971 representing the fixed exchange rate period; and 1973 to 2001 representing the flexible exchange rate period. This division allows me to study

accounts and current accounts at banks.

13. According to the Bank of Canada annual report, the 90-day commercial paper rate, considered to be a short-term interest rate is a key monetary policy variable. Siklos and Anusiewicz (1998) also used this variable.

14. Fama (1990) showed that results for the Standard and Poor's 500 Index are similar to those for the NYSE value-weighted portfolio.

the potential integration between stock returns and the exchange rate. Further details on the sources of data are provided in the Appendix.

The plots of variables in levels and in first differences are illustrated in Figures 1 and 2, respectively. From Figure 1, all the variables except INFL and M1 seem to display an obvious trend with a non-zero mean, and GNP and M1 exhibit strong seasonality; but Figure 2 shows that the first differences of the time series variables almost seem to meander in a random walk process.[15] Somewhat interestingly, figure 2 also shows increased volatility of the exchange rate during the flexible exchange rate period.

5. EMPIRICAL RESULTS

5.1 Results of Unit Root Tests

As a preliminary step, both the Elliott, Rothenberg and Stock (1996) DF-GLS test and the ADF test were applied to the levels and first differences of each variable to determine its order of integration. I employ the Modified Akaike Information Criterion to find the appropriate lag length for both tests (the maximum lag length chosen automatically by EViews 4.1 is 13). According to Figure 1, the level series such as real GNP, the industrial production index (IP), exports (EP), the nominal interest rate (IR), the real exchange rate (EXR), the TSE and the US stock price index (US) contain an obvious trend; therefore, I carry out both tests on the level series including both a constant and trend in the test regression, while for the inflation rate (INFL) and the money supply (M1) I include only a constant in the regression. Following the same principle, I apply the two tests to all first-differenced series including only a constant. The test results are reported in Table 1 for the

15. Chen (1991) noted that the use of seasonally unadjusted data avoids the use of future data that is an important consideration for any ex-ante implications that may be drawn. Moreover, according to Lee and Siklos (1995), (1) the presence if unit roots at some seasonal frequencies does not have an effect on cointegration tests at the zero frequency. Thus, the Johansen procedure can be effective in the presence of unit roots at other seasonal frequencies. (2) The distribution of the test statistics of cointegration is not changed by additional seasonal dummy if a constant is included.

ADF test and in Table 2 for the DF-GLS test. The null hypothesis of the existence of a unit root for the levels series cannot be rejected at even the 10% significance level with constant and linear trend using both the ADF and DF-GLS tests. According to the ADF test, the null hypothesis can be rejected for the first-differenced series at at least the 10% significance level for all variables except real GNP, whereas the DF-GLS test fails to reject the unit root hypothesis for the first-differences of M1 and the nominal interest rate (IR). Since it is wise not to mix variables with different orders of integration when testing for cointegration, GNP, M1 and the nominal interest rate (IR) are discarded in further analysis.

5.2 Results of Cointegration Tests

Johansen's cointegration test is used to explore the long-run equilibrium relationship between the Toronto stock index (TSE) and five macroeconomic variables including the industrial production index (IP), exports (EP), the real exchange rate (EXR), inflation (INFL) and the US stock price index (US). The results of the test can be quite sensitive to the lag length in cointegration analysis, so the choice of lag length is important. Starting from a maximum lag of 8, the lag order p is first estimated using a model selection procedure based on the Akaike Information Criterion (AIC).[16] The optimal lag length p is found to be 4 in the unrestricted VAR (3 in the VECM). As to the deterministic trend specification, because there are trends in the variables, I perform the cointegration test allowing for a linear deterministic trend in the data, but only an intercept in the cointegrating equations.

Table 3 presents the results of the cointegration tests. Using the Trace test, I can reject the null hypothesis that there are no long-term co-movements between stock prices and macroeconomic variables at the 5% level of significance, specifically confirming the presence of two cointegrating relations among the variables, but at the 1% level of

16. EViews 4.1 also provides the likelihood ratio (LR) test statistic as one criterion. But fortunately, the results for the LR and the AIC are identical in this case. The appendix provides the details about the LR statistic.

significance, the Trace statistics suggest that there is only one cointegrating vector between the variables. The Maximum-eigenvalue statistic cannot reject the null hypothesis of the existence of two cointegrating vectors at the 5% level of significance, but fails to find significant evidence of cointegration at the 1% level of significance. The difference in results between the two tests may be attributable to the omission of important causing variables. At the 5% level of significance, both the Trace and Max-eigenvalue tests show that the number of cointegrating vectors is equal to two, so I conclude that there are two permanent components governing the long-term co-movements of the variables. This result supports the hypothesis that a long-run equilibrium exists between the TSE index and macroeconomic variables. Table 3 also reports the trace statistic that has been corrected for small sample bias.[17] Using the 10% level of significance I can reject the null hypothesis of no cointegrating relation, also confirming that there is a long-term equilibrium in the model.

Since the above test results revealed that the variables are cointegrated, I can estimate the coefficients of the cointegrating vectors within the framework of the VECM to explore the dynamic long-run equilibrium among the variables. In the presence of two cointegrating vectors, I analyze the first, considered to be the most useful. Accordingly, the coefficient values of the first cointegrating vector can be described in following order: TSE (normalized to one), EP, EXR, INFL, IP, US and a constant.

$$\beta_1 = (1.0000, -0.0535, 0.9659, -4.8411, -0.534805, -0.4056, -2.6152). \quad (5.1)$$

These values represent the long-term elasticity measures, due to the logarithmic transformation. The cointegrating vector can be expressed as:

$$TSE=0.0535EP-0.9659EXR+4.8411INFL+0.534805IP+0.4056US+2.6152. \quad (5.2)$$

Equation (5.2) shows that as I hypothesized, there is a positive relationship between the TSE and Canadian real economic activities, as measured by exports (EP) and the industrial

17. See section 3.3 in this paper.

production index (IP), which can be viewed as proxies for future cash flows. This result is consistent with results for the US (Chen, Roll and Ross 1986; Fama 1990) and Japan (Mukherjee and Naka 1995). Increases in exports and industrial production in Canada lead to increases in future cash flows as well as in Canadian stock prices. I also find that there is a negative relationship between the real exchange rate and the TSE index. Aggarwal (1981) obtained the same results with respect to the revaluation of the US dollar and stock market returns. In contrast, Roll (1992) found a positive relationship using US data. Also contrary to my expectations and most empirical results (e.g., Chen et al. 1986, Fama 1990, Schwert 1990), the TSE index responds positively to the inflation rate, which is the wrong sign according to the relevant economic theory.

Finally, the relationship between the TSE index and the US stock price index is positive. A similar relationship is also found between the Japanese and US stock market indices by Becker et al. (1990). The result that the US stock price index is positive and significant in the cointegrating vector reflects the fact that the Canadian and US economies are increasingly linked together; i.e., a large fraction of goods and services is exported from Canada to the US.

Further, I found that the long-run elasticity of the inflation rate is the highest - up to 4.8411- followed by the exchange rate (EXR), the industrial production index (IP) and the US stock price index (US), and finally exports (EP). This finding suggests that inflation has a large impact on the Toronto stock market, consistent with the results of the US experience revealed by Chen, Roll and Ross (1986). The international factors as proxied by the real exchange rate and the US stock price index have a relatively large influence on the Toronto stock market index, compared to real economic activity as proxied by the industrial production index.

Following Mukherjee and Naka (1995), I impose restrictions on the cointegrating vectors to explore the robustness of the results with respect to the signs of the coefficients. Table 4 presents the signs of the coefficient estimates in each possible five-variable model that includes TSE. Comparing the number of positive and negative signs for the six models, the results confirm my conclusions above. Exports (EP), the industrial production index (IP) and the US stock price index enter the equation with economically meaningful signs. The finding of a negative relationship between TSE and the real exchange rate may be explained in part by the difference in the frequency of data on the exchange rate and the stock markets.The result obtained, however, is consistent with the analysis being conducted from an international investor's perspective; according to Phylaktis and Ravazzolo (2002), the exact relation between stock returns and the real exchange rate is unclear. The wrong sign of the relationship between the stock price and inflation could be traced to the omission of some important economic events that occurred during in my sample period. In Canada's economic history, Canada experienced a rapid acceleration in inflation before 1975. In response, the Anti-Inflation Act was introduced and the Bank of Canada has since been keeping an eye on a low and stable inflation rate. But this important policy change has not been incorporated directly in the model (Siklos and Anusiewica 1998).

To check which variables actually contribute to this long-term equilibrium, I also use exclusion restriction tests on TSE and the other five variables. Since there is more than one cointegrating vector, I analyze the first eigenvector corresponding to the largest eigenvalue in accordance with Johansen and Juselius (1990). They showed that the first eigenvector is most correlated with the stationary part of the model.[18]

Table 5 reports the results of the likelihood-ratio exclusion restriction tests on the first cointegrating vector. As shown in the table, the chi-square statistic for excluding TSE is 7.020887 and is statistically significant at even the 1% significance level, indicating that TSE contributes to this cointegrating relation. Additionally, I can reject the null hypotheses of the

18. The long-term equilibrium relation with the second-eigenvalue is similar to the one associated with the largest eigenvalue.

non-existence in the cointegrating relation of the real exchange rate (EXR) and the US stock price index (US) at the 5% significance level and the industrial production index (IP) at the 10% significance level (p-value is 0.092460). However, the exclusion restriction for inflation (INFL) and exports (EP) cannot be rejected at the 10% level of significance. Therefore, TSE, EXR, IP and US do belong to the cointegrating relation, but INFL and EP do not.

An interpretation of the above findings is that the long-term co-movements of the industrial production index (IP), the short-term interest rate (EXR) and the US stock price index (US) may enter into the long-term co-movements of Canadian stock returns. The cointegration between the TSE and the US stock index reflects the fact that in recent years, global markets have gradually become more integrated as a result of a broad tendency toward liberalization and deregulation in the money and capital markets of developed economies.

Additionally, I examined the estimated coefficients considered to be the speed of adjustment parameters of the error correction model. The values of the estimated parameters are given in the following order: TSE, IP, INFL, EXR, EP, US.

$$a = (-0.257792, 0.000321, 0.013163, 0.013537, -0.014490, -0.095727) \quad (5.3)$$

The speed of adjustment measures how quickly the variables adjust to the long-run relationship reflected in the first cointegrating vector. The magnitudes of the estimated parameters indicate that in absolute value, the speed of adjustment for TSE is most rapid followed by that of the US stock price index. The speed of adjustment for industrial production is slowest. With respect to the sign, -0.257792 is the speed of adjustment of TSE to deviations from the long-run equilibrium; 0.000321, 0.013163 and 0.013537 measure the speeds of adjustment of IP, INFL and EXR, respectively, to the same deviation from the long-run equilibrium; and -0.014490 and -0.095727 measure the speed of adjustment of EP and US, respectively, to the opposite deviation from the long-run equilibrium. A likelihood ratio test of the significance of each adjustment coefficient is conducted with the results reported in

Table 6. As shown in the table, at the 5% level of significance the chi-square statistics for TSE and INFL are statistically significant. However, I cannot reject the null hypothesis for EP, IP and US at even the 10% significance level. This result demonstrates that TSE adjusts quickly to the long-term equilibrium, but EP, EXR, IP and US appear to be weakly exogenous to the system.

Further sub-period analysis

To examine the effect on stock market returns across fixed and flexible exchange rate regimes, the cointegration analysis is performed further on the two sub-periods, 1963:1-1971:4, a period of fixed exchange rates in Canada; and 1973:1-2001:4, the flexible exchange rate period. The results for the two sub-periods are summarized in Table 7. For the first period, both the trace statistic and the max-eigenvalue statistic indicate the existence of at least one cointegrating vector at any conventional level of significance. For the second period, using both the trace test and the max-eigenvalue test I can also reject the null hypothesis and arrive at the same conclusion: a cointegrating equilibrium exists between the variables. Therefore, the results strongly indicate that there are long-term co-movements between the variables for both sub-periods.

As for the entire period, I apply exclusion restriction tests to the cointegrating vectors for the two sub-periods. Table 8 summarizes the results. In the fixed exchange rate period, the chi-square statistics for TSE, EP, EXR and IP are not significant at even the 10% significance level, but I can reject the null hypothesis of non-existence in the cointegrating relation for INFL and US at any conventional significance level (p-values are 0.000001 and 0.001845, respectively). This finding indicates that the permanent component in the TSE does not enter into a cointegrating relationship with those in the macroeconomic variables during the 1963-1971 periods, but there appears to be a common trend driving Canadian inflation and the US stock price index in the long run. During the fixed exchange rate period, short-run changes in the exchange rate have not been closely linked to the fluctuations in the corresponding national inflation rates that determine expected real activity; as a result, the exchange rate has no effect on stock prices.

In contrast to the fixed exchange rate period, for the flexible exchange rate period the chi-square statistics for TSE and all macroeconomic variables except inflation are large enough that I can reject the null hypothesis at any conventional significance level. This finding indicates that the TSE index does contribute to the cointegrating relation and that macroeconomic variables except the inflation rate play a role in the long-term movements of the Toronto stock market in the flexible exchange rate period.

One interpretation of the above results is that the higher exchange rate variability during the floating exchange rate period has a greater effect on the level of domestic aggregate demand and the level of output. Thus, the stock market is more influenced by international disturbance transmission under the flexible exchange rate regime than under the fixed exchange rate regime, resulting in relatively stronger long-run co-movements between stock market returns and macroeconomic variables.

5.3 Granger Causality Test Results

Granger causality analysis can provide insight into the short-run dynamics between stock market returns and macroeconomic variables. Since there exist long-term co-movements between the Toronto stock market index (TSE) and macroeconomic variables including the industrial production index (IP), exports (EP), the real exchange rate (EXR), inflation (INFL) and the US stock price index (US) for entire period and both sub-periods, it is relevant to determine the actual direction of causality among the variables. In context of this paper, I apply the method for multivariate Granger Causality tests introduced by Dolado and Lutkepohl (1996) for the whole period and the second sub-period (representing the flexible exchange rate period) and focus on analyzing the latter results.[19] Gross national production (GNP), the short-term interest rate (IR) and the growth rate of the money supply (M1) are added to the six-variable model analyzed in the previous sections because of the advantage of the method.

Following Dolado and Lutkepohl (1996), the basic VAR equation in this case is as follows:

$$\begin{bmatrix} TSE_t \\ GNP_t \\ EP_t \\ EXR_t \\ INP_t \\ IR_t \\ INFL_t \\ M1_t \\ US_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} TSE_{t-1} \\ GNP_{t-1} \\ EP_{t-1} \\ EXR_{t-1} \\ INP_{t-1} \\ IR_{t-1} \\ INFL_{t-1} \\ M1_{t-1} \\ US_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} TSE_{t-2} \\ GNP_{t-2} \\ EP_{t-2} \\ EXR_{t-2} \\ INP_{t-2} \\ IR_{t-2} \\ INFL_{t-2} \\ M1_{t-2} \\ US_{t-2} \end{bmatrix} + \ldots + A_m \begin{bmatrix} TSE_{t-m} \\ GNP_{t-m} \\ EP_{t-m} \\ EXR_{t-m} \\ INP_{t-m} \\ IR_{t-m} \\ INFL_{t-m} \\ M1_{t-m} \\ US_{t-m} \end{bmatrix} + \begin{bmatrix} \varepsilon_{TSE} \\ \varepsilon_{GNP} \\ \varepsilon_{EP} \\ \varepsilon_{EXR} \\ \varepsilon_{INP} \\ \varepsilon_{IR} \\ \varepsilon_{INFL} \\ \varepsilon_{M1} \\ \varepsilon_{US} \end{bmatrix} . \quad (5.4)$$

where the A_i are 9×9 coefficient matrices and m is the number of lags actually used in the system. It should be noted that I add extra lags to insure that the test is carried out on the safe side, particularly, since there is uncertainty as to the order of cointegration of the variables.

Since the optimal lag specification selected by using Akaike Information Criterion (AIC) was $p = 4$ for the entire period and the second period, and the variables GNP, M1 and IR appear to be I (2), the actual lag length used in the VAR model upon which the tests are based is 6. Table 9 and table 10 summarize the Granger causality relations between Canadian stock market returns and macroeconomic variables for the whole period and the flexible exchange rate period, respectively.

Starting with the measures of real economic activity, as shown in table 9, the null hypothesis of non-causality from GNP to TSE cannot be rejected, because the Wald statistic

19. I drop the observations from 1963 to 1971, because most literatures have well documented the relationship between the stock price index and macroeconomic variables under flexible exchange rate regime. Moreover, the Canadian stock market has been more open to the international market since the flexible exchange rate began. The movements in the stock market should be quite different in different circumstances.

(7.2506888) is statistically insignificant at the 10% significance level. In the reverse direction, I can reject the null hypothesis in favor of a causal effect running from TSE to GNP. The same direction of causality is also found between TSE and exports (EP). The null hypothesis of Granger non-causality running from the industrial production index (IP) to TSE can be rejected at the 10% significance level, but causality in the opposite direction does not occur. From table 10, I can reject the null hypothesis of non-causality in both directions for GNP and IP at the 10% significance level. However, the Granger causality results for EP are the same as for the whole period. Hence, the Toronto stock market responds incompletely to real economic news. Particularly, under the flexible exchange rate period, the past information contained in the industrial production index as a measurement of domestic industry in Canada can forecast future stock prices; however, the lagged Canadian stock market index could rationally be explained as signals for future development in both domestic industry and the export industry.[20] An interpretation of these findings is that domestic production is a more significant factor determining the Canadian business cycle than the export industry. Gjerde and Sattem (1999) found a significant causal relation running from real economic activity to stock returns but failed to detect the reverse effect in the small open economy of Norway.

Secondly, table 9 and table 10 show the following identical results: the null hypothesis of non-causality running from the growth rate of the money supply to TSE cannot be rejected, because the p-values are very high (0.73976 and 0.89703, respectively); but at even the 1% significance level, I can reject the null hypothesis of non-causality in the reverse direction. The growth rate of the money supply is weakly exogenous in predicting the TSE returns, in contrast with the results of Siklos and Anusiewica (1998). Using weekly monetary announcement data, they revealed that unexpected Canadian M1 weekly growth leads to a

20. GNP includes domestic industry and export industry.

fall in the Canadian stock market index.

Thirdly, as reported in table 9, since the Wald statistics in the two directions are statistically insignificant (0.56730837 and 6.0426122, respectively), I cannot identify a significant causal relation between TSE and inflation, indicating that inflation does not have a significant impact on TSE and vice versa. The results in table 10 support this conclusion strongly. According to money demand theory, the increase in the demand for real money balances induced by an increase in real economic activity should lead to a declining price level; since stock returns are assumed to respond positively to expected real economic activity, there may be a negative causal relation between Canadian stock returns and expected inflation. In my empirical model, there is no causal relation between stock returns and the growth rate of the money supply; therefore, there is no causal relation between stock returns and inflation. This finding is consistent with those for the US stock market (Fama 1981) and Norway's stock market (Gjerde and Sattem 1999). However, James et al. (1985) employed a VARMA analysis and found that expected inflation has a negative and significant effect on the Standard and Poor 500 stock index.

Fourthly, from table 9, I cannot reject the null hypothesis of non-presence of Granger causality between TSE and the short-term interest rate in both directions, since the p-values (0.12210 and 0.39936, respectively) exceed even 10%, In contrast, table 10 shows that as hypothesized before, I can reject the null hypothesis that there is no causal relation running from the short-term interest rate to TSE at any conventional significance level; but causality in the opposite direction cannot be rejected at even the 10% significance level (p-value is 0.11589), a result which is compatible with Siklos and Anusiewica (1998). Under a flexible exchange rate regime, to achieve a long-run monetary aggregate target, it will require a relatively short time period for the central bank to take some monetary policy actions. Such actions will have their effect through short-term interest rates, and financial markets are also affected. Previous empirical studies have well documented a negative causal relation between stock returns and the interest rate in the US stock market (James et al.1985) and the UK stock market (Poon and Taylor 1991).

Fifthly, table 9 shows that at any conventional significance level, the null hypothesis of non-causality running from the real exchange rate to TSE cannot be rejected, but the Wald statistic (13.012394) for the opposite direction is statistically significant at the 5% significance level, implying that the TSE Granger-causes the real exchange rate. This unidirectional causality can be explained by the finding of an insignificant influence of Canadian money surprises on the exchange rate by Siklos and Anusiewicz (1998). By contrast, from table 10, the p-values are so small that I can reject the null hypothesis of non-causality in both directions at any conventional significance level, consistent with the 27 emerging stock markets (Bilson et al 2000). Whether stock price movements Granger cause exchange rate volatility or vice versa depends on the country and time periods in the previous empirical literature.[21]

Finally, according to table 9, I cannot reject the null hypothesis that there is no causal relation from the US stock price index to the TSE, indicating that the Canadian stock market may not be affected by the transmission of financial market shocks from larger markets, particularly the US market. Somewhat strikingly, a significant causality relation exists from the TSE returns to the US stock market (the Wald statistic is 10.815914). From table 10, however, the Wald statistic (9.6416507) for the Granger causality from the US stock price index to the TSE is statistically significant at the 5% significance level and causality in the opposite direction also does occur, reflecting that under the flexible exchange rate regime, the Canadian stock market became more linked with the world market. Siklos and Anusiewicz (1998) found that during the inflation-targeting era in Canada, an increase in US stock prices

21. The decrease in the demand of money will lead to an interest rate decrease, causing a further outflow of funds and hence depreciating the currency.

pushed Canadian stock prices lower. In the Japanese stock market case, Kent et al. (1990) suggested that the US S&P 500 could explain from 7 to 25% of the fluctuations in the Nikkei Index, demonstrating that U.S stock performance has a great impact on the Japanese stock market. Central European stock markets, considered to be emerging stock markets, show non-causality with the US stock market in the two directions (Gilmore and McManus 2002). According to the *efficient market hypothesis*, then, the Canadian stock market presents a certain degree of inefficiency.[22]

Robustness of the result for TSE and US stock price index

To examine the robustness of the causality relation between TSE and US stock price index, I check the bi-variable causality relations using the same method for three sample periods: the whole period (1963-2001), the flexible exchange rate period (1973-2001) and the North American Free Trade Agreement (NAFTA) period (1989-2001).[23] During the whole period, at even the 10% significance level, I cannot reject the null hypothesis of non-causality between the TSE and the US stock price index in both directions. However, under the flexible exchange rate regime, I can reject the null hypothesis of non-causality running from the US stock price to TSE at the 5% significance level, and causality in the opposite direction does not occur at any conventional significance level. The bi-variable Granger causality results for the NAFTA period are the same as under flexible exchange rate. Taking all causality results for TSE and US stock price index in account, I find a robust positive relation running from the US stock price index to TSE and an unclear casaulity relation in the opposite way. These differences may be due to the different sample period and different lag lengths.

22. An efficient market is defined by Fama (1981) as a market in which prices always fully reflect available information.

23. The North American Free Trade Agreement (NAFTA) is an important event for US and Canada, because the objectives of this Agreement including national treatment, most-favored-nation treatment and transparency is to eliminate barriers to trade, to increase substantially investment opportunities and to create a more effective economy environment for both US and Canada.

6. CONCLUSION

A large number of studies well document a relationship between the stock market and macroeconomic variables that are excellent candidates for extra market risk factors. By employing Johansen's cointegration tests and the Granger causality approach, I investigate the long-run dynamics and short-run causal relationship between Toronto stock market returns and macroeconomic variables, namely real GNP, the industrial production index, the real exchange rate, the short-term interest rate, inflation, exports, the growth rate of the money supply, and the US stock market price index, using quarterly data for the period 1963-2001. Furthermore, I examine how stock market returns are influenced after the shift from fixed to flexible exchange rates.

As a result, I found the presence of two cointegrating relations between the Toronto stock market index and macroeconomic variables for the whole period as expected, implying that a common trend drives them in the long term. The signs of the long-term elasticity coefficients of the cointegrating vector indicate that there is a positive relationship between the Toronto stock index and the industrial production index as well as the US stock price index. Inconsistent with the hypothesis, the stock index responds negatively to exports. The sign of the exchange rate and the growth rate of the money supply are unclear. Further, exclusion restriction tests suggest that the TSE contributes to the cointegrating relation and the real exchange rate, industrial production index and the US stock market index are considered to be the significant determinants of the Toronto stock returns. The Toronto stock market returns are relatively sensitive to aggregate demand as an indicator of economic output (the industrial production index) and international factors (the exchange rate and the US stock market index). With respect to the speed of adjustment, I found that TSE has a quick and significant adjustment to the long-run equilibrium but exports, the real exchange rate, the industrial production index and the US stock price index appear to be weakly exogenous to the system.

The empirical analysis is repeated for two sub-periods. I find that cointegration exists in the two periods, but the TSE index does not actually belong to the cointegrating relationship in the fixed exchange rate period. In the flexible exchange rate period the long-term co-movements of the TSE index can be explained by the industrial production index, exports, the real exchange rate and the US stock market index.

Comparing the multivariate Granger causality tests results for the whole period with those for the flexible exchange rate period, I found the latter better fit the hypothesis in section 2. Under the flexible exchange rate regime, among the macroeconomic variables selected in this paper there are bi-directional causal relationships between GNP, the industrial production index, the real exchange rate and the US stock market index. However, there is uni-directional causality running from the TSE index to the short-term interest rate and from the exports and the growth rate of money supply to the TSE index. Non-causality exists between the TSE index and inflation in both directions. Further, I find a robust positive relation running form US stock price index to TSE and an unclear casualty relation in the opposite direction.

Some of the unexpected results in this paper could be attributed to (1) the fact that the model does not capture exhaustively all the important macroeconomic factors, i.e., some other relevant variables missing from my model may also enter the long-term relationship with the TSE; (2) the frequency of the data in this paper is slightly low, (3) the limitations on the data; and(4) the choice of macroeconomic variables, such as substituting the term spread to short-term interest rate, so further research can be suggested to further explore the dynamic behavior of the TSE index.

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Figure 1. Time Series Behavior of the Log of the Variables in Level

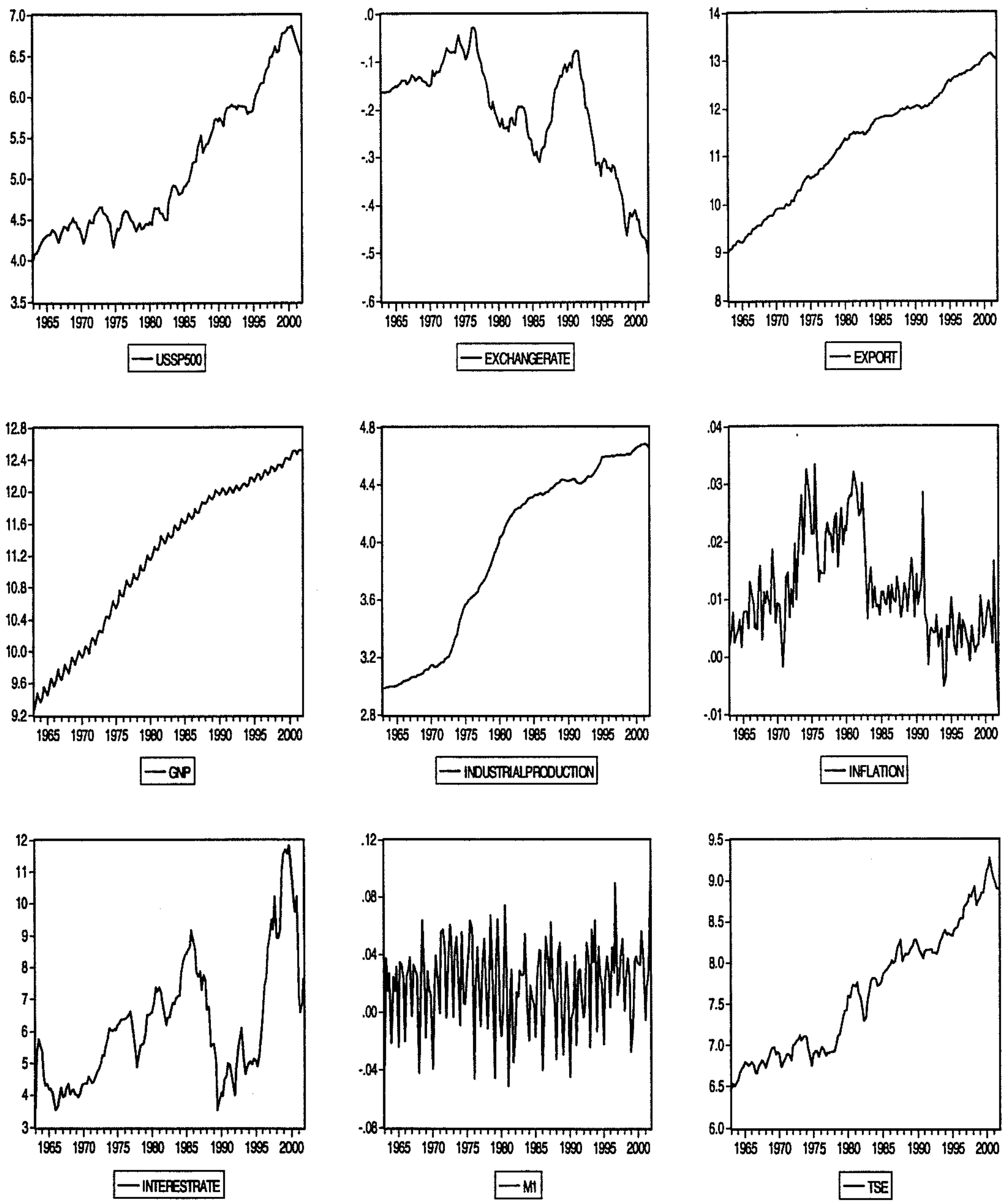

Figure 2. Time Series Behavior of the Log of the Variables in First Difference

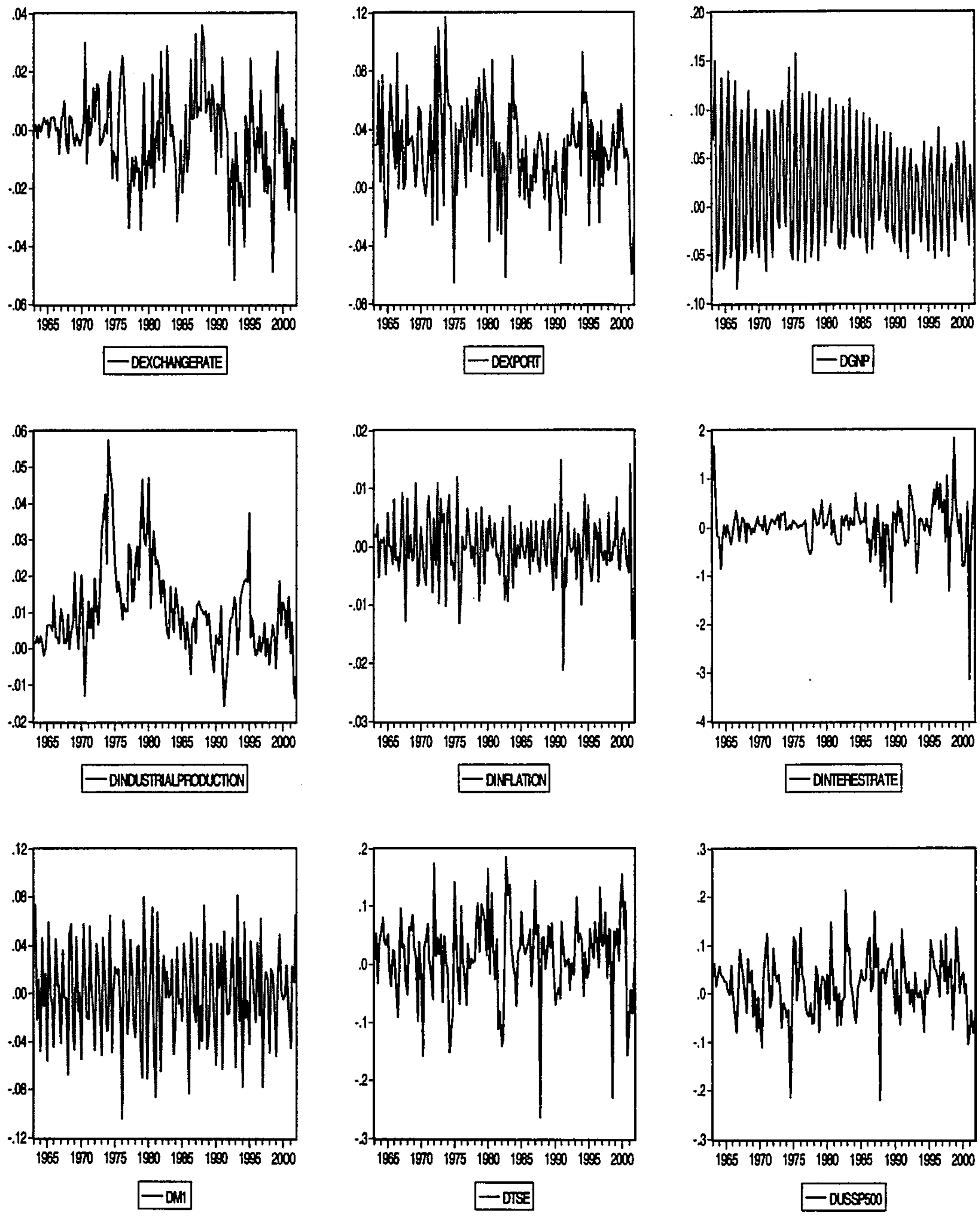

Table 1. Augmented Dickey Fuller (ADF) Unit Root Test Results

Variables	Lag length	Level	Lag length	First Difference
GNP	3	0.090298	8	-1.094394
IP	5	-0.630789	3	-1.767905*
M1	11	-2.340989	0	-17.08826***
IR	0	-2.340989	3	-5.185651***
INFL	3	-1.683976	0	-16.51896***
EXR	4	-1.590439	8	-2.7770567***
EP	0	-0.960621	9	-1.765025*
US	10	-1.512375	13	-2.263609**
TSE	7	-2.168568	11	-2.908816***

Note:

1. *** indicates statistically significant at the 1 percent level, ** indicates statistically significant at the 5 percent level and * indicates statistically significant at the 10 percent level.

2. The critical values are based on MacKinnon (1991).

3. EViews 4.1 automatically selected the appropriate lag length, based on the MAIC.

Table 2: Ellott,Rothenberg and Stock (DF-GLS) Unit Root Test Results

Variables	Lag length	Level	Lag length	First Difference
GNP	3	-0.160558	8	-1.657129*
IP	5	-1.102741	3	-2.017254**
M1	12	-0.083979	13	-0.277402
IR	0	-2.0062190	12	-0.176140
INFL	3	-1.282198	11	-2.015068**
EXR	4	-1.332249	8	-2.779910***
EP	3	-1.014298	2	-5.108836***
US	1	-1.700242	8	-1.802538*
TSE	7	-1.922917	11	-1.896351*

Note:

1. *** indicates statistically significant at the 1 percent level, ** indicates statistically significant at the 5 percent level and * indicates statistically significant at the 10 percent level.

2. EViews 4.1 automatically selected the appropriate lag length, based on the MAIC.

Table 3. Johansen's Cointegration Test Results for the Whole Period

Hypothesized No. Of CE	H_1	Trace statistic	Trace statistic(corrected)	Hypothesized No. Of CE	H_1	Max-Eigenvalue
$r = 0$	$r \geq 0$	113.7586**	100.2872***	$r = 0$	r=1	41.80003*
$r \leq 1$	$r > 1$	71.95859*	63.43718	$r = 1$	r=2	33.90162*
$r \leq 2$	$r > 2$	38.05697	33.55022	$r = 2$	r=3	15.62629
$r \leq 3$	$r > 3$	22.43068	19.77442	$r = 3$	r=4	13.08619
$r \leq 4$	$r > 4$	9.344485	8.237901	$r = 4$	r=5	7.667260
$r \leq 5$	$r > 5$	1.677225	1.478606	$r = 5$	r=6	1.677225
Optimal lag In the VECM	3			3		

Note:

1. *, ** and *** denotes rejection of the hypothesis at the 5%, 1%, and 10% level.

2. The critical values are used from Osterwald-Lenum (1992).

3. Corrected means that the statistic includes a finite sample correction.

Table 4. Sign of the Coefficients

	INFL	EP	EXR	IP	US
All variables	+	+	-	+	+
Deleting one variables					
Without INFL		+	-	+	+
Without EP	+		-	+	+
Without EXR	+	+		-	+
Without IP	+	-	+		+
Without US	+	+	-	-	
Conclusion	+	+	-	+	+

+ means positive,- means negative

Table 5. Cointegration Restriction Test Results

Cointegration Restriction	χ^2	P-value	Conclusion
Without TSE	7.020887	0.008056	Reject H_0
Without INFL	0.362397	0.547178	Do not reject H_0
Without EP	0.100672	0.751024	Do not reject H_0
Without EXR	6.604897	0.010170	Reject H_0
Without IP	2.831015	0.092460	Reject H_0
Without US	5.433421	0.019755	Reject H_0

Table 6. Results of Cointegration Restriction Test on the Speed of Adjustment

Cointegration Restriction on the speed of adjustment	χ^2	P-value	Conclusion
TSE	5.717333	0.016798	Reject H_0
INFL	4.301869	0.038071	Reject H_0
EP	0.134943	0.713361	Do not reject H_0
EXR	0.807116	0.368974	Do not reject H_0
IP	0.001264	0.971644	Do not reject H_0
US	1.553663	0.212595	Do not reject H_0

Table 7. Johansen's Cointegration Test Results for Two Sub-periods

Trace statistic			Maxi-Eigenvalue		
Hypothesized No. Of CE	1963:1-1971:4	1973:1-20001:4	Hypothesized No. Of CE	1963:1-1971:4	1973:1-20001:4
r =0	123.3629**	131.4652**	r =0	52.10426**	51.25136**
$r \leq 1$	68.52*	80.21380**	$r = 1$	28.25401	35.52829*
$r \leq 2$	47.214	44.68551	$r = 2$	22.44186	23.00434
$r \leq 3$	29.68	21.68117	$r = 3$	13.36555	11.71773
$r \leq 4$	15.41	9.963441	$r = 4$	5.574696	8.857973
$r \leq 5$	3.76	1.105468	$r = 5$	1.622482	1.105468
Optimal lag in the VECM	0	3	Optimal lag in the VECM	0	3

Note

1. *(**) denotes rejection of the hypothesis at the 5 % (1%) level.

2. Optimal lag is chose by sequential modified likelihood ratio criterion.

3. The critical values are used by Osterwald-Lenum(1992).

Table 8.Cointegration Restriction Test Results For Two Sub-periods

Cointegration Restriction	1963:1-1971:4		1973:1-20001:4	
	χ^2	P-value	χ^2	P-value
Without TSE	0.979411	0.322344	14.82736	0.000118
Without INFL	23.65068	0.000001	2.37E-06	0.998773
Without EP	2.158319	0.141800	4.586582	0.032223
Without EXR	0.485458	0.485960	9.101558	0.002554
Without IP	2.045573	0.152649	10.20313	0.001402
Without US	9.697341	0.001845	10.86443	0.000980

Table 9. Granger Causality Test Results for whole period

Independent variables X	Dependent Variables Y	Wald χ^2	p-value	Causality X→Y	Independent variables Y	Dependent Variables X	Wald χ^2	p-value	Causality Y→X
GNP	TSE	7.2506888	0.12322	No	TSE	GNP	8.6385148	0.07080	Yes
IP	TSE	7.8496828	0.09724	Yes	TSE	IP	2.8295446	0.58674	No
EP	TSE	2.7058575	0.60819	No	TSE	EP	12.994221	0.01130	Yes
M1	TSE	1.9782260	0.73976	No	TSE	M1	14.096410	0.00699	Yes
INFL	TSE	0.56730837	0.96663	No	TSE	INFL	6.0426122	0.19599	No
IR	TSE	7.2740191	0.12210	No	TSE	IR	4.0494443	0.39936	No
EXR	TSE	6.7503166	0.14969	No	TSE	EXR	13.012394	0.01122	Yes
US	TSE	5.5094740	0.23890	No	TSE	US	10.815914	0.02871	Yes

→ indicates Grange causality relation; Yes indicates significant causal relationship at the 10% level of significance; No indicates no significant causal relationship.

Table 10. Granger Causality Test Results for the period 1973-2001

Independent variables X	Dependent Variables Y	Wald χ^2	p-value	Causality X→Y	Independent variables Y	Dependent Variables X	Wald χ^2	p-value	Causality Y→X
GNP	TSE	18.382536	0.00104	Yes	TSE	GNP	26.102418	0.00003	Yes
IP	TSE	8.3278099	0.08028	Yes	TSE	IP	10.487110	0.03298	Yes
EP	TSE	4.9632981	0.29108	No	TSE	EP	21.037610	0.00031	Yes
M1	TSE	1.0825643	0.89703	No	TSE	M1	15.950744	0.00309	Yes
INFL	TSE	0.56730837	0.96663	No	TSE	INFL	7.0289839	0.13436	No
IR	TSE	13.793686	0.00798	Yes	TSE	IR	7.4067475	0.11589	No
EXR	TSE	20.524132	0.00039	Yes	TSE	EXR	16.383558	0.00255	Yes
US	TSE	9.6416507	0.04692	Yes	TSE	US	20.301055	0.00044	Yes

→ indicates Grange causality relation; Yes indicates significant causal relationship at the 10% level of significance; No indicates no significant causal relationship.

Data Appendix

1. Data Source

Variables	Source	Mnemonics	Frequency
TSE	Statistics Canada CANSIM II	Table 176-00471 V122620	Monthly
Real GNP	Statistics Canada CANSIM II	Table 380-0015 V499688	Quarterly
Industrial Production Index (IP)	Statistics Canada CANSIM II	Table 329-0038 V3822562	Monthly
Short-term interest rate	Statistics Canada CANSIM II	Table 176-00431 V122491	Monthly
Narrow defined money supply (M1)	Statistics Canada CANSIM II	Table 176-00201 V37200	Monthly average
Spot exchange rate (nominal)	Statistics Canada CANSIM II	Table 176-0049 V37694	Monthly
Export of good and service	IMF CD-ROM	Series code 15690C.CZF	Quarterly
Canada Consumer Price Index (CPI)	IMF CD-ROM	Series code 15664…ZF…	Quarterly
US Consumer Price Index (CPI)	IMF CD-ROM	Series code 11164…ZF…	Quarterly
US Standard and Poor's Index (US)	Website of Robert J. Shiller http://aida.econ.yale.edu/~shiller/	Stock market data	Monthly

2. Lag length Criteria

Starting from the maximum lag, test the hypothesis that the coefficients on lag l are jointly zero using the χ^2 statistics

$$LR = (T-n)\{\log|\Omega_{l-1}| - \log|\Omega_l|\} \sim \chi^2(k^2)$$

Where n is the number of parameters per equation under the alternative. In this case, I use Sims' (1980) small sample modification which uses (T-n) rather than T. Then, I compare the modified LR statistics to the 5% critical values starting from the maximum lag, and decreasing the lag one at a time until rejection.