Globalization And Time Varying Prices Of Market And Foreign Exchange Risks: Canadian Evidence

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ABSTRACT

The paper empirically examines the relationship between stock returns, exchange rate, and market risks for the Canadian stock market operating in an increasingly global environment. Time varying prices of market and currency risks and corresponding risk premia are estimated. We investigate how estimated risk premia in different industry sectors are affected by macroeconomic events associated with globalization. We find that magnitude of shocks is greater, and risk premia at the times of economic shocks are greater in the post-1994 than in pre-1994 period, and this increase seems to be driven by the increased market exposure of stock returns.

Keywords: globalization, currency risk, market risk

INTRODUCTION

$\mathcal{G}$iven Canada's heavy reliance on international product and capital markets, all Canadian firms are directly and indirectly exposed to foreign exchange rate risk, regardless of whether their operations are domestic or multinational. Various regulatory, and institutional changes accompanied by increased globalization of commerce is generally expected to have a major impact on trade-oriented economies such as Canada. Performance of firms listed in Toronto Stock Exchange, therefore, can be thought of as barometers measuring the impact of these ongoing changes in the Canadian market.

The main purpose of this paper is to estimate the influences of the market and foreign exchange risks on stock returns in Canada. We employ the multifactor pricing framework based on the CAPM of Sharpe (1964, 1965) and international asset pricing model (IAPM) of Adler and Dumas (1983). The model is estimated with a sample of five industry portfolios, an equally weighted index, and US$ exchange rate changes using monthly data starting in August 1976 and ending in December 2001. The prices of risk and risk premia are recovered by jointly estimating a seven-variate model based on the conditional IAPM of De Santis and Gerard (1998).

Initial view of the trade agreements such as Free Trade Agreement (FTA) and North American Free Trade Agreement (NAFTA) attributed abnormal stock returns to expect gains from comparative advantages and economies of scale for participating countries.[i] The U.S. economic recession of 2001-2003 revived the discussion regarding the costs and benefits of NAFTA. For instance, Hansen and Song (2002) report insignificant or negative effects of the agreement on U.S. industries and positive effects on Mexican industries. Rodriguez (2003) found strong evidence that capital-intensive U.S. companies were expected to benefit from NAFTA and similar but weaker results for Canadian industries. Most of these studies utilized event study technique to uncover the effects of political news on stock returns.

Our study is intended to contribute to the extent literature in two fronts. First, we study five industry portfolios of Canadian stocks with a view to understanding the implications of growing internationalization with a primary focus on the Canadian investor. Second, the employment of De Santis and Gerard (1998) methodology enables us to test the pricing restrictions and to study the relative magnitude and the dynamics of both currency and

market risk premia applicable to Canadian market. To the best of our knowledge, this is the first paper that analyzes the effect of globalization in Canada by uncovering dynamics of prices of market and currency risks and corresponding risk premia jointly at the industry level, as opposed to event study techniques employed in earlier research. We view liberalization as a gradual process and use implementation of NAFTA in January 1994 merely as a logical division point between two subperiods, pre-1994 (lower degree of liberalization) and post-1994 (higher degree of liberalization). We by no means imply that the changes in market pricing found in this study occurred instantly on January 1994 and solely because of NAFTA.

We explicitly model the time varying aspect of the risk premia by employing a multivariate generalized autoregressive conditional heteroscedastic (MGARCH) framework. The MGARCH framework resolves some of the problems present in the univariate models. In particular, MGARCH makes it possible to estimate model parameters jointly, thus allowing for multivariate error distribution. Common MGARCH representations include Vech, diagonal, constant conditional correlation, BEKK in Engle and Kroner (1995), and others such as in Gourieroux and Jasiak (2001).[ii,iii] These models have been successfully applied to economic problems. Recent studies include Turtle et al. (1994), Karolyi and Stulz (1996), Kroner and Ng (1998), Tse (2000), and Engle (2002), among others.

Our investigation of how estimated risk prices and risk premia in Canada are affected by macroeconomic events associated with globalization finds strong evidence that the prices of currency and market risk are time-varying. We find that the price of currency risk is a significant component of asset pricing in the Canadian market. We also find evidence that globalization had significant impact on pricing in the Canadian stock market. The prices of market and exchange rate risks exhibit increased variability over recent years suggesting increased influence of external factors on Canadian stock prices. Market and currency premia for all industry sectors also exhibit similar pattern, although the magnitudes of the effect are industry-specific.

The rest of the paper is organized as follows. In the next section the econometric method used in this study is developed. Section III describes the data and Section IV reports the results and discusses the empirical evidence. Section V concludes the paper.

MODEL AND METHODOLOGY

We analyze the conditional version of a multifactor model that incorporates both market risk and currency risk. The market risk is a well known risk factor since the Capital Asset Pricing Model of Sharpe (1964), and the concept of currency risk was originally developed by Adler and Dumas (1983). Dumas and Solnik (1995) and De Santis and Gerard (1998), among others, present ample evidence of the significance of the currency risk in pricing stock returns.

The theoretical relationship investigated in this paper is:
$$E[r_i] = \lambda_{FX}\sigma_{i,FX} + \lambda_M \sigma_{i,M} , \tag{1}$$
where, $r_i \equiv (\tilde{r}_i - r_f)$ is excess return over the riskless rate, $\sigma_{i,M}$ is the instantaneous covariance between the excess returns of asset i and the market excess return, $\sigma_{i,FX}$ is the instantaneous covariance between the excess returns of asset i and change in the exchange rate $\tilde{r}_{FX}$ in excess of the riskless rate, λ_{FX} is the price of foreign exchange risk and λ_M is the price of market risk. Both prices of risk are assumed to depend on relative risk aversion of investors within a country. We assume that prices of currency and market risks are determined within the aggregate national capital market and are the same within specific market segments. In this study segments of Canadian stock market are represented by excess returns of five randomly selected industry indices. Canadian market portfolio is proxied by CFMRC equally weighted index.[iv] A series of exchange rate changes represents the foreign exchange rate risk of Canadian companies.[v] The model is as follows:

$$r_{i,t} = \lambda_{M,t-1} \operatorname{cov}_{t-1}(r_{i,t}, r_{M,t}) + \lambda_{FX,t-1} \operatorname{cov}_{t-1}(r_{i,t}, r_{FX,t}) + e_{i,t}, \; i = 1, \ldots 5 \tag{2}$$

$$r_{M,t} = \lambda_{M,t-1} \operatorname{var}_{t-1}(r_{M,t}) + \lambda_{FX,t-1} \operatorname{cov}_{t-1}(r_{M,t}, r_{FX,t}) + e_{M,t}, \tag{3}$$

$$r_{FX,t} = \lambda_{M,t-1} \operatorname{cov}_{t-1}(r_{FX,t}, r_{M,t}) + \lambda_{FX,t-1} \operatorname{var}_{t-1}(r_{FX,t}) + e_{FX,t}, \tag{4}$$

$$e_{1,t}, \ldots e_{5,t}, e_{M,t}, e_{FX,t} \sim N(0, \mathbf{H}_t)$$

where,

$$\lambda_{M,t-1} = \exp[k_{1,0} + k_{1,1} \cdot z_{1,t-1} + k_{1,2} \cdot z_{2,t-1} + k_{1,3} \cdot z_{3,t-1} + k_{1,4} \cdot z_{4,t-1}] \tag{5}$$

$$\lambda_{FX,t-1} = k_{2,0} + k_{2,1} \cdot z_{1,t-1} + k_{2,2} \cdot z_{2,t-1} + k_{2,3} \cdot z_{3,t-1} + k_{2,4} \cdot z_{4,t-1} \tag{6}$$

We use instrumental variables $z_{i,t}, i = 1, \ldots, 4$ that include term premium (TP), default premium (DP), dividend yield (DY), and previous month's market excess return, $r_{M,t-1}$. We also restrict the price of market risk to be positive by using an exponential function in (5), and make no such restriction on the price of foreign exchange risk in (6).[vi]

Dynamic variance-covariance matrix is specified as diagonal BEKK with variance targeting which, according to Engle and Mezrich (1996), improves performance of the estimator in finite samples and reduces the number of parameters. Therefore, we estimate the following specification of $\mathbf{H}_t$:

$$\mathbf{H}_t = \mathbf{H}_0 \circ (\mathbf{ii' - aa' - bb'}) + \mathbf{a}e_{t-1}\mathbf{e'}_{t-1}\mathbf{a' + b}\mathbf{H}_{t-1}\mathbf{b'} \tag{7}$$

where, $\mathbf{H}_0$ is unconditional 7x7 variance-covariance matrix, "$\circ$" denotes Hadamard product, $\mathbf{i}$ is a 7x1 vector of ones, and finally $\mathbf{a}$ and $\mathbf{b}$ are diagonal matrices of coefficients with respective elements denoted by $\alpha_1, \ldots, \alpha_7$, and $\beta_1, \ldots, \beta_7$. The system is estimated using the Marquardt algorithm under assumption of multivariate normality.[vii]

DATA AND SUMMARY STATISTICS

We employ a sample of five Canadian industry sector indices of firms listed in the Toronto Stock Exchange along with the equally weighted TSX300 index as a proxy for the market portfolio. This data is obtained from the Canadian Financial Market Research Centre (CFMRC). The three-month Canadian Treasury bill yield is used as the risk free rate. Based on the availability of data, we limit our study period to 215 monthly observations starting in February 1984 and ending in December 2001.[viii] Excess returns are obtained by subtracting the three-month Canadian Treasury bill yield. We use the U.S. dollar exchange rate, expressed in Canadian dollars per U.S. dollar.

Following Dumas and Solnik (1995), De Santis and Gerard (1998), and Carrieri et al. (2003) we use five information (instrumental) variables in our estimation procedure. These include a constant, change in the exchange rate (XR), dividend yield in excess of the risk free rate (DY), term premium on Canadian Government bonds (TP), default premium of corporate bonds (DP), and the lagged excess return on the market portfolio ($r_{M,t-1}$). DP is measured by the yield difference between Moody's Baa-rated and aa-rated bonds.[ix] TP is measured by the difference between the long-term Government of Canada 10-year maturity bonds and the three-month Treasury bill rates.

Table 1 reports the descriptive statistics of the key variables. Panel A reports the summary statistics for the excess return series of five industry indices, the market index and the change in exchange rate. The table indicates strong evidence that the data series do not conform to the assumptions of normality. This conclusion is based on the fact that all unconditional sample skewness measures are significantly different from zero, and the kurtosis measures are significantly larger than the critical value of three. Furthermore, Jarque-Berra and ADF tests reject the

hypothesis that the series are normal at zero level of significance. Rejection of the normality assumption on the data series is inconsistent with linearity and constancy of the conditional variance, and it suggests the appropriateness of GARCH modeling in analyzing the series.

Table 2 reports the descriptive statistics of the information variables. Again, the skewness and kurtosis measures indicate non-normality of all five series. Jarque-Berra and ADF tests for the normality of the series also reject the hypothesis that the series are normal at zero level of significance.

Table 1
Descriptive Statistics of Data Series

Panel A: Descriptive Statistics

	Metals and Mining	Oil and Gas	Industrial Products	Conglomerates	Consumer Products	Market Index Return [a]	Currency [b]
Mean	0.0016	0.0021	0.0021	0.0051	0.0059	0.0091	-0.0048
Median	0.0007	0.0026	0.0015	0.0026	0.0056	0.0061	-0.0057
Maximum	0.2344	0.2286	0.2341	0.1537	0.1488	0.3670	0.0280
Minimum	-0.3145	-0.2271	-0.3865	-0.2294	-0.2326	-0.2936	-0.0295
Std. Dev.	0.0723	0.0661	0.0755	0.0566	0.0511	0.0629	0.0116
Skewness	-0.1353	0.1820	-0.5714	-0.1338	-0.8079	0.4268	0.2745
Kurtosis	4.7807	4.2993	6.7848	4.2711	6.1993	10.2706	2.5374

Panel B: Correlations

	Metals and Mining	Oil and Gas	Industrial Products	Conglomerates	Consumer Products	Market Index[a] Return	Currency[b]
Metals and Mining	1.0000						
Oil and Gas	0.4929	1.0000					
Industrial Products	0.4303	0.2016	1.0000				
Conglomerates	0.6342	0.5333	0.4463	1.0000			
Consumer Products	0.4098	0.2392	0.6158	0.5377	1.0000		
Market Index	0.5133	0.5161	0.5780	0.5364	0.5406	1.0000	
Currency	-0.2053	-0.0858	-0.1839	-0.1921	-0.1702	-0.2108	1.0000

[a] Equally weighted
[b] Change in nominal exchange rate

EMPIRICAL RESULTS

We estimate the multivariate model outlined by equations 1, 2 and 3, and the results are reported in Table 3[x]. Panels A and B report parameter estimates for the mean equations. Coefficients for the market index for both market and currency risks are both positive and significant, which may indicate that high market returns in the past are expected to increase both market and currency risk premia. This result is consistent with increasing relative risk aversion of investors. Individual significance of the coefficients related to the other information variables is relatively low, possibly due to high cross-correlation of the returns and information variables, reported in Table 1 and Table 2, which may have led to high multicolinearity. Panels C and D report the conditional variance processes. Panel E reports the results of diagnostic tests. As shown in Panel A, three of the five coefficients are statistically significant, indicating that the market premium of risk is a significant factor in asset pricing. The mean equation coefficients associated with foreign exchange rate reported in Panel B, show that the coefficient associated with market is significant.[xi]

Table 2
Descriptive Statistics of Information Variables

Panel A: Descriptive Statistics

	Market Index Return (t-1)	Change in Term Premium (t-1)	Change in Default Premium (t-1)	Change in Dividend Yield (t-1) [a]
Mean	0.0087	0.0000	0.0001	0.0000
Median	0.0059	0.0002	0.0000	0.0000
Maximum	0.3670	0.0132	0.0247	0.0006
Minimum	-0.2936	-0.0234	-0.0111	-0.0004
Std. Dev.	0.0628	0.0049	0.0027	0.0001
Skewness	0.4434	-1.0429	2.9632	0.6401
Kurtosis	10.3539	6.9992	36.8707	7.2691
Jarque-Bera	491.5038	182.2454	10591.8400	177.9531
Probability	0.0000	0.0000	0.0000	0.0000
ADF	-11.8403[***]	-8.3710[***]	-15.7775[***]	-14.5505[***]
Probability	0.0000	0.0000	0.0000	0.0000
ADF of Levels [b]	-11.8403[***]	-2.4782	-2.7290[*]	-1.0874
Probability	0.0000	0.1222	0.0708	0.7209
Observations	215	215	215	215

Panel B: Correlations

Market Index Return (t-1)	1.0000			
Change in Term Premium (t-1)	0.0396	1.0000		
Change in Default Premium(t-1)	-0.1237	-0.1488	1.0000	
Change in Excess Dividend Yield(t-1)	-0.6204	0.0785	0.0479	1.0000

[a] Monthly (not annualized), in fractions of 1 rather than percentage to be comparable with returns, series obtained from Solnik and McLeavey (2002) textbook, the web address is:
http://wps.aw.com/aw_solnik_intlinv_5/0,7654,716896-,00.html
[b] Instruments 2, 3, and 4 are often used in level form in the literature.
[***] indicates 1% significance, [**] indicates 5% significance, [*] indicates 10% significance level.

These results suggest that both the market and currency risks are significant factors in pricing of Canadian stocks. This finding is consistent with those of Dumas and Solnik (1995) who find that the currency risk is a significant factor in international asset pricing.

Panel C and D of Table 3 reveal that all parameter estimates associated with the ARCH and GARCH processes are statistically significant. Consistent with the results of De Santis and Gerard (1998), our GARCH coefficients are considerably larger than the corresponding ARCH coefficients. This indicates that the current second moment is more influenced by its own lagged value than past innovations. Bollerslev (1986) shows that for each process in H_t to be stationary, the condition $\alpha_i \, \alpha_j + \beta_i \beta_j < 1$ has to be satisfied. Panel E of Table 3 presents model diagnostics, which shows that the model is adequate.

Table 4 reports the probabilities of Ljung-Box Statistics of residuals associated with five, ten, fifteen and twenty-period lags. High p-values reported in panel A for standard residuals indicate adequacy of the corresponding mean equations. High p-values of squared residuals reported in Panel B indicate adequacy of the corresponding variance equations.

Results of Likelihood ratio tests of the main hypotheses examined in this study are reported in Table 5. We estimated a number of restricted models and compared log likelihood with unrestricted models. The unrestricted model in Table 5 is the one whose output is in Table 3. Restricted models have (1) no market price of risk, (2) a constant as market price of risk, (3) no currency risk coefficients, and (4) a constant as price of currency risk. All hypotheses are rejected at the 1% level, indicating that both prices of risk are significant and time varying.

Table 6 reports the descriptive statistics of price of risk. The range of the market price of risk is generally within the range graphed in Dumas and Solnik (1995). The mean price of market risk and currency risk are 3.9015 and 1.9513 respectively. The price of market risk and the price of currency risk reported here are comparable to those of Carrieri et al. (2003) and De Santis and Gerard (1998). The estimated price of the currency risk is more volatile: the standard deviation of the price of market risk is 7.1038, while the standard deviation of the price of the currency risk is 13.3469. Furthermore, the range for the price of market risk is 97.6438 (from 0.2372 to 97.8810) while the range for the price of currency risk is 154.634 (from -56.7527 to 76.4921).

Exhibit 1 presents the estimated trajectories of the prices of the market and foreign exchange risks in the Canadian market. De Santis and Gerard (1998) point out that these estimates are volatile and subject to estimation error. Therefore, more attention needs to be paid to the general trend than to a plotted value at a given point in time. Following their suggestion we plot Hodrick-Prescott (HP) filtered prices. [xii] Examination of the graphs reveals three large spikes in the price of the market risk. The first spike takes place in late 1987, the second occurs around 1993, and the last spike is around 1997. We hypothesize that these spikes are related to the 1987 US stock market crash, the currency crises in the European Monetary System in 1992-1993, and to the Asian Flu in 1997-1998. Note that the spikes in the price of Canadian market risk grow in magnitude: the smallest is in 1987, the spike in 1993 is larger than the previous, and the largest is in 1997. Examination of the time path of the Canadian price of currency risk also reveals a number of spikes that mostly correspond to the spikes in the price of the market risk. In general, we observe that the magnitude of spikes increased in recent years for the prices of both market and currency risks.

A similar picture emerges when we examine time paths of estimated risk premia for the market index, the currency index, and five industry portfolios presented in Exhibit 2. Even though the estimated magnitudes of the spikes for risk premia differ from industry to industry, in all cases one could see larger peaks in the market risk premium, currency premium, and total premiums taking place in recent years.[xiii] Table 7 presents medians for top and bottom deciles of the estimated risk premia[xiv]. It clearly shows that the differences between the top and bottom deciles become larger for the second subperiod, indicating that magnitude of the shocks in the second subperiod grew larger. For example, the difference between the top and bottom market premium deciles for Metals and Mining is 0.0234-0.0024=0.0210 for the first subsample and 0.1592-0.0020=0.1571 for the second subsample. One could speculate that as markets became more liberalized in recent years, the impact of external shocks on the Canadian stock market became larger[xv].

However, the question remains whether these shocks had a lasting effect on the Canadian markets by causing statistically significant changes in affecting average values of the risk prices, risk exposures, and the risk premia. To formally investigate whether distributional characteristics of the prices of risks and risk premia changed over time, we follow De Santis et al (2003). We divide the sample into two sub-samples around January 1994 and test whether means of key data series remained the same across the subsamples[xvi]. We study whether estimated total, market, and currency premiums changed as the process of globalization progressed. Table 8 shows that no statistically significant change in the average risk premia was detected, even though the economic significance of the changes is evident: estimated average change in the total risk premium for the Market index is 0.0912, which is almost 6 times the estimated pre-1994 value of 0.0153[xvii]. We conjecture that no significant changes in the average risk premia are observed because the capital markets may have already adjusted, on average, to the new political environment, taking into account that the timeline of the political events is known far in advance.[xviii]

Table 3
Parameter Estimates

The estimated model is as follows:

$$r_{i,t} = \lambda_{M,t-1} \text{cov}_{t-1}(r_{i,t}, r_{M,t}) + \lambda_{FX,t-1} \text{cov}_{t-1}(r_{i,t}, r_{FX,\cdot t}) + e_{i,t}, \quad i = 1,...,5 \tag{2}$$

$$r_{M,t} = \lambda_{M,t-1} \text{var}_{t-1}(r_{M,t}) + \lambda_{FX,t-1} \text{cov}_{t-1}(r_{M,t}, r_{FX,t}) + e_{M,t}, \tag{3}$$

$$r_{FX,t} = \lambda_{M,t-1} \text{cov}_{t-1}(r_{FX,t}, r_{M,t}) + \lambda_{FX,t-1} \text{var}_{t-1}(r_{FX,t}) + e_{FX,t}, \tag{4}$$

$$e_{1,t},...,e_{5,t}, e_{M,t}, e_{FX,t} \sim N(0, \mathbf{H}_t)$$

where,

$$\lambda_{M,t-1} = \exp[k_{1,0} + k_{1,1} \cdot z_{1,t-1} + k_{1,2} \cdot z_{2,t-1} + k_{1,3} \cdot z_{3,t-1} + k_{1,4} \cdot z_{4,t-1}] \tag{5}$$

$$\lambda_{FX,t-1} = k_{2,0} + k_{2,1} \cdot z_{1,t-1} + k_{2,2} \cdot z_{2,t-1} + k_{2,3} \cdot z_{3,t-1} + k_{2,4} \cdot z_{4,t-1} \tag{6}$$

Instrumental variables $z_{i,t}, i = 1,...,4$ are previous month's market excess return, $r_{M,t-1}$, change in term premium (TP), change in default premium (DP), and change in dividend yield (DY). Price of market risk is restricted to be positive by using exponential function in (4). No such restriction on the price of foreign exchange risk in (5).

Panel A: Mean Equation Coefficients Associated with Market Index

	Constant	Market	TP	DP	DY
Coefficient	0.9434***	9.7423***	72.2883*	-22.2137	258.7240
Std. Error	0.2468	0.4750	41.4146	47.6289	726.6872
t-stats	3.8219	20.5122	1.7455	-0.4664	0.3560

Panel B: Mean Equation Coefficients Associated with Foreign Exchange Rate

	Constant	Market	TP	DP	DY
Coefficient	0.1334***	205.2877*	609.7279	45.6792	-78.3020
Std. Error	0.6038	110.6441	1234.2847	208.8903	217.2016
t-stats	0.2208	1.8554	0.4940	0.2187	-0.3605

Panel C: ARCH Coefficients

	alpha(1)	alpha(2)	alpha(3)	alpha(4)	alpha(5)	alpha(6)	alpha(7)
Coefficient	0.3885***	0.5127***	0.3320***	0.2396***	0.1638***	0.3605***	0.2307***
Std. Error	0.0590	0.0521	0.0261	0.0447	0.0272	0.0356	0.0679
t-stats	6.5790	9.8357	12.7374	5.3588	6.0126	10.1122	3.3953

Panel D: GARCH Coefficients

	beta(1)	beta(2)	beta(3)	beta(4)	beta(5)	beta(6)	beta(7)
Coefficient	0.5210***	0.5110***	0.9183***	0.8282***	0.9789***	0.5379***	0.6762***
Std. Error	0.1527	0.1354	0.0126	0.0051	0.0089	0.0904	0.1976
t-stats	3.4113	3.7750	72.8608	161.5653	110.4060	5.9527	3.4224

Panel E: Diagnostics

Log Likelihood	3600.9112
Number of observations	215
Number of coefficients	24
Akaike information criterion	-33.2735
Schwarz criterion	-32.8973
Hannan-Quinn criterion.	-33.1215

*** indicates 1% significance, ** indicates 5% significance, * indicates 10% significance level.

A greater degree of liberalization could imply a greater exposure to outside shocks. To further investigate whether or not external shocks affected Canadian capital markets in the earlier sub-period the same way as in the later sub-period, we conduct tests for mean changes for the outliers only, keeping in mind that at the times of economic shocks capital market variables tend to exhibit extreme values. For the prices of market and currency risks, risk exposures, and risk premia, we construct series that include only bottom 5% and top 5% of the observations for each subsample. We present tests for the structural breaks between pre-1994 and post-1994 in period's average risk premia for the outliers in Table 9. It shows significant increases in the total risk premia for 6 out of 7 stock indices. For example, an increase in the average total premium at the times of economic shocks in the post-1994 period was 0.7438 for the market index, with the corresponding t-value of 2.0564. We also observe increases in the market and currency premia, although many of the estimated changes are not statistically significant. Examination of Table 10 shows no significant change in the average prices of market or currency risks, while Table 11 shows significant increase for all 7 cases in the average market exposure and significant decrease for 4 out of 7 cases for average currency exposure during turbulent periods. Thus, the average increases in the total risk premia at the times of economic shocks seem to be associated by increased average market exposure of Canadian stock returns.

CONCLUSION

The paper empirically examines importance of the exchange rate and market risks in Canadian stock markets. Canadian equity portfolio returns and other economic data are used in a multivariate GARCH-M framework to capture the time varying aspects of price of exchange rate risk. We find strong evidence that prices of currency and market risks are time-varying. This is consistent with current literature including De Santis and Gerard (1998), Dumas and Solnik (1995) and Carrieri et al. (2003). Our results indicate that price of currency risk is a significant component of asset pricing in the Canadian market. Also, it is the market risk premia that dominate the total risk. We find evidence that the magnitude of economic shocks in the Canadian markets increased after 1994. We discover evidence of significant structural changes in average risk premia and market exposures during pre-1994 versus post-1994 crises. Increased market liberalization leads to a greater degree of interdependence and less effective diversification, and subsequently higher than pre-1994 systematic risk premia at the times of shocks.

Table 4
Probabilities of Ljung-Box Q statistics of Residuals

Panel A: Residuals

Series:	Met. & Mining	Oil & Gas	Ind. Products	Conglomerates	Cons. Products	Market Index	Currency
Lags	Res1	Res2	Res3	Res4	Res5	Res6	Res7
5	0.819	0.538	0.235	0.533	0.756	0.720	0.001
10	0.860	0.780	0.475	0.673	0.624	0.899	0.000
15	0.964	0.750	0.139	0.676	0.884	0.927	0.000
20	0.921	0.766	0.362	0.613	0.912	0.968	0.000

Panel B: Squared Residuals

	Sq. Res1	Sq. Res2	Sq. Res3	Sq. Res4	Sq. Res5	Sq. Res6	Sq. Res7
5	0.501	0.675	0.755	0.643	0.864	0.269	0.891
10	0.890	0.963	0.976	0.898	0.987	0.770	0.890
15	0.980	0.997	0.999	0.980	0.997	0.965	0.965
20	0.985	0.999	1.000	0.938	0.937	0.996	0.276

Note: Residuals are standardized by fitted standard deviation, squared residuals are standardized by variance, and product residuals are standardized by corresponding covariance.

Table 5
Tests of Price of Risk

	Hypothesis/Restriction	LR Test Statistic	Degrees of Freedom	p-value
1.	Price of market risk is Zero	16395.12[***]		0.0000
	$k_{1,1} = k_{1,2} = k_{1,3} = k_{1,4} = k_{1,5} = 0$		5	
2.	Price of market risk is Constant	597.6529[***]		0.0000
	$k_{1,2} = k_{1,3} = k_{1,4} = k_{1,5} = 0$		4	
3.	Price of currency risk is Zero	12.4039[**]		0.0297
	$k_{2,1} = k_{2,2} = k_{2,3} = k_{2,4} = k_{2,5} = 0$		5	
4.	Price of currency risk is Constant	12.2957[**]		0.0153
	$k_{2,2} = k_{2,3} = k_{2,4} = k_{2,5} = 0$		4	
5.	ARCH elements are irrelevant	435.0669[***]		0.0000
	a(i)=0, i=1, …, 7		7	
6.	GARCH elements are irrelevant	116257.3[***]		0.0000
	b(i)=0, i=1, …, 7		7	
7.	Variance is constant	2.37E+08[***]		0.0000
	a(i)=0, b(i)=0, i=1, …, 7		14	

[***] indicates 1% significance, [**] indicates 5% significance, [*] indicates 10% significance level.

Table 6
Descriptive Statistics of Prices of Risk

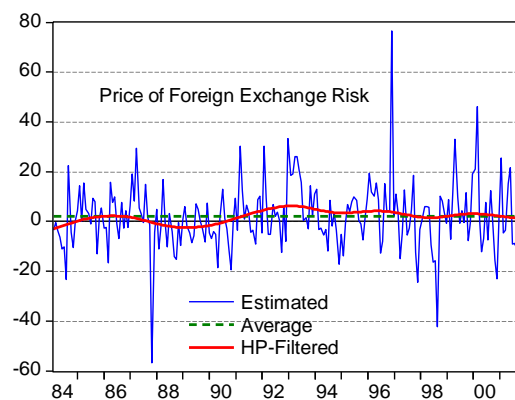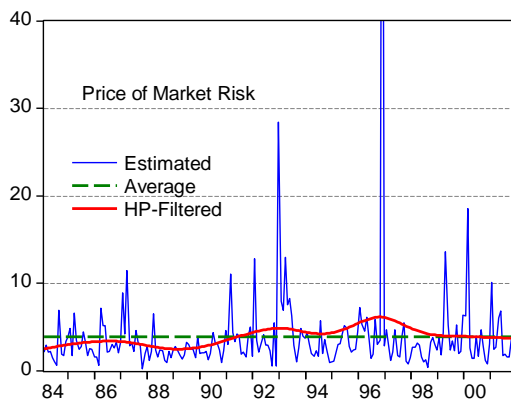|	Mkt Risk Price	FX Risk Price
Mean	3.9015	1.9513
Median	2.7250	0.5175
Maximum	97.8810	76.4921
Minimum	0.2372	-56.7527
Dev.	7.1038	13.3469
Skewness	11.1135	0.5946
Kurtosis	144.6209	8.8839
Jarque-Bera	184098.4	322.8122
Probability	0.0000	0.0000
Observations	215	215

Exhibit 1: Estimated Prices of Risks
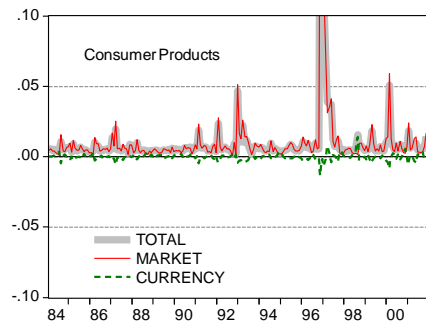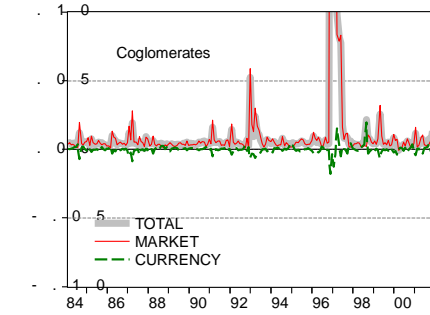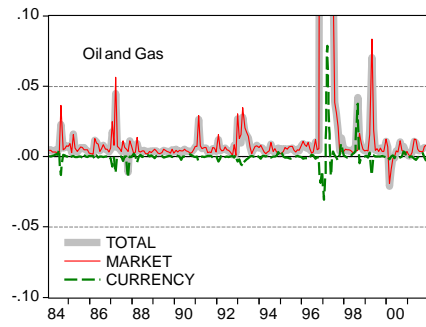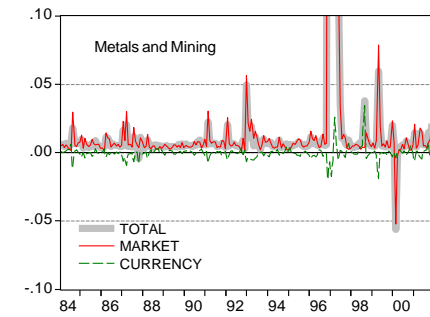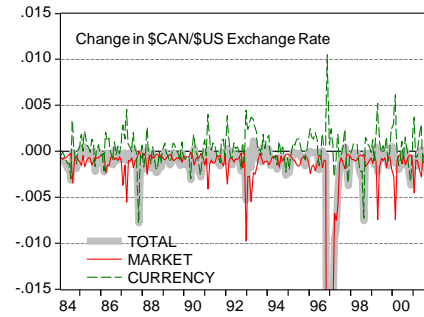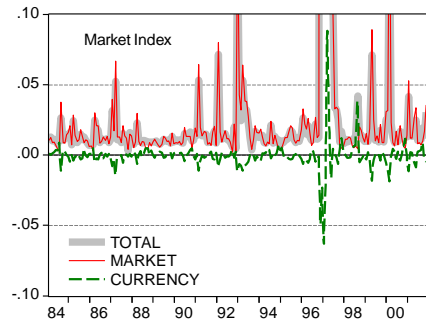
Exhibit 2 Risk Premia Estimates
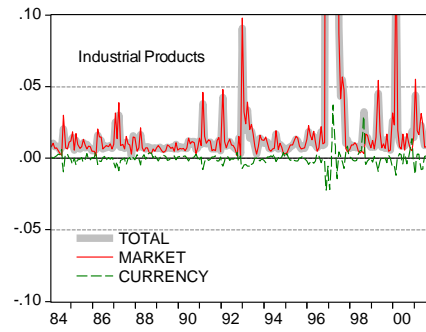
Table 7
Medians of the Top and Bottom Deciles for Estimated Total, Market, and Currency Risk Premia

The risk premia as computed as follows: Total premium, $TP_i = \hat{\lambda}_{FX}\hat{\sigma}_{i,FX} + \hat{\lambda}_M\hat{\sigma}_{i,M}$, Market premium, $MP_i = \hat{\lambda}_M\hat{\sigma}_{i,M}$, and Currency premium, $CP_i = \hat{\lambda}_{FX}\hat{\sigma}_{i,FX}$, where $\hat{\lambda}_M$ and $\hat{\lambda}_{FX}$ are estimated prices of the market and currency risks, $\hat{\sigma}_{i,M}$ and $\hat{\sigma}_{i,FX}$ are estimated conditional covariances of the return i with the market and currency index.

	Metals and Mining	Oil and Gas	Industrial Products	Conglomerates	Consumer Products	Market Index	Currency
Total risk premia, 1984-1993:							
Median of highest decile	0.0177	0.0174	0.0264	0.0134	0.0137	0.0341	0.0003
Median of lowest decile	0.0035	0.0025	0.0054	0.0027	0.0032	0.0070	-0.0023
Market risk premia, 1984-1993:							
Median of highest decile	0.0234	0.0226	0.0320	0.0181	0.0165	0.0412	-0.0002
Median of lowest decile	0.0024	0.0020	0.0030	0.0015	0.0017	0.0041	-0.0035
Currency risk premia, 1984-1993:							
Median of highest decile	0.0025	0.0013	0.0030	0.0018	0.0019	0.0040	0.0034
Median of lowest decile	-0.0065	-0.0050	-0.0058	-0.0046	-0.0039	-0.0083	-0.0020
Total risk premia, 1994-2001:							
Median of highest decile	0.1747	0.5775	0.2849	0.0901	0.0448	0.6148	0.0003
Median of lowest decile	0.0037	0.0004	0.0065	0.0023	0.0039	0.0087	-0.0089
Market risk premia, 1994-2001:							
Median of highest decile	0.1592	0.5559	0.2841	0.0831	0.0500	0.5625	-0.0004
Median of lowest decile	0.0020	0.0007	0.0039	0.0014	0.0020	0.0049	-0.0075
Currency risk premia, 1994-2001:							
Median of highest decile	0.0052	0.0038	0.0083	0.0034	0.0031	0.0103	0.0030
Median of lowest decile	-0.0061	-0.0118	-0.0104	-0.0042	-0.0044	-0.0184	-0.0024

Table 8
Average Estimated Risk Premia

The table contains the coefficient estimates of the regressions of the estimated risk premia from the model with time-varying risk on a constant and a dummy variable for the post-January 1994 period, where $D_t = 1$, if $t >$ January 1994, and $D_t = 0$ otherwise.

The risk premia as computed as follows: Total premium, $TP_i = \hat{\lambda}_{FX}\hat{\sigma}_{i,FX} + \hat{\lambda}_M\hat{\sigma}_{i,M}$, Market premium, $MP_i = \hat{\lambda}_M\hat{\sigma}_{i,M}$, and Currency premium, $CP_i = \hat{\lambda}_{FX}\hat{\sigma}_{i,FX}$, where $\hat{\lambda}_M$ and $\hat{\lambda}_{FX}$ are estimated prices of the market and currency risks, $\hat{\sigma}_{i,M}$ and $\hat{\sigma}_{i,FX}$ are estimated conditional covariances of the return i with the market and currency index. Standard errors are computed using the Newey-West heteroskedasticity and autocorrelation robust procedure.

	Metals and Mining	Oil and Gas	Industrial Products	Conglomerates	Consumer Products	Market Index	Currency
Total Premium:							
Pre-1994	0.0069***	0.0064***	0.0109***	0.0056***	0.0064***	0.0153***	-0.0009***
t-stats	11.6460	8.9480	9.9774	8.5787	10.9893	8.4839	-8.8113
Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Change Post-1994	0.0236	0.0561	0.0313	0.0139	0.0073	0.0912	-0.0015
t-stats	1.3318	1.3698	1.6073	1.3025	1.4291	1.3553	-1.3582
Prob.	0.1844	0.1722	0.1095	0.1942	0.1544	0.1768	0.1758
Market premium:							
Pre-1994	0.0077***	0.0070***	0.0115***	0.0061***	0.0068***	0.0162***	-0.0011***
t-stats	9.3663	7.6620	8.6111	7.2170	9.0633	7.4312	-7.5575
Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Change Post-1994	0.0231	0.0551	0.0310	0.0137	0.0073	0.0913	-0.0016
t-stats	1.2868	1.3482	1.5779	1.2529	1.3734	1.3421	-1.3183
Prob.	0.1996	0.1790	0.1161	0.2116	0.1711	0.1810	0.1888
Currency premium:							
Pre-1994	-0.0007**	-0.0006**	-0.0006**	-0.0005**	-0.0003*	-0.0009**	0.0002
t-stats	-2.4898	-2.4204	-2.0069	-2.2510	-1.7701	-1.9930	1.1257
Prob.	0.0135	0.0163	0.0460	0.0254	0.0781	0.0475	0.2615
Change Post-1994	0.0005	0.0010	0.0003	0.0002	0.0000	-0.0001	0.0001
t-stats	0.6592	1.0852	0.3252	0.4350	-0.0068	-0.0554	0.3315
Prob.	0.5105	0.2790	0.7454	0.6640	0.9946	0.9559	0.7406

*** indicates 1% significance, ** indicates 5% significance, * indicates 10% significance level.

Table 9
Average Estimated Risk Premia During Economic Shocks

The table contains the parameter estimates of the regressions of the outliers (top 5% and bottom 5%) of the estimated risk premia from the model with time-varying risk on a constant and a dummy variable for the post-January 1994 period (D_t=1, if t > January 1994, and D_t=0 otherwise). The risk premia as computed as follows: Total premium, $TP_i = \hat{\lambda}_{FX}\,\hat{\sigma}_{i,FX} + \hat{\lambda}_M\,\hat{\sigma}_{i,M}$, Market premium, $MP_i = \hat{\lambda}_M\,\hat{\sigma}_{i,M}$, and Currency premium, $CP_i = \hat{\lambda}_{FX}\,\hat{\sigma}_{i,FX}$, where $\hat{\lambda}_M$ and $\hat{\lambda}_{FX}$ are estimated prices of the market and currency risks, $\hat{\sigma}_{i,M}$ and $\hat{\sigma}_{i,FX}$ are estimated conditional covariances of the return *i* with the market and currency index. Standard errors are computed using the Newey-West heteroskedasticity and autocorrelation robust procedure.

	Metals and Mining	Oil and Gas	Industrial Products	Conglomerates	Consumer Products	Market Index	Currency
Total Premium:							
Pre-1994	0.0106***	0.0123**	0.0175***	0.0085***	0.0100***	0.0262***	-0.0018*
t-statistic	3.5141	2.2784	3.7033	3.5588	3.4504	3.0732	-2.0692
Probability	0.0025	0.0351	0.0016	0.0022	0.0029	0.0066	0.0532
Change Post-1994	0.1859*	0.4076*	0.1973**	0.1155*	0.0536	0.7438*	-0.0113
t-statistic	1.8315	1.7982	2.1721	1.8285	1.6422	2.0564	-1.5745
Probability	0.0836	0.0889	0.0435	0.0841	0.1179	0.0545	0.1328
Market premium:							
Pre-1994	0.0145***	0.0169**	0.0203***	0.0109***	0.0114***	0.0302***	-0.0021**
t-statistic	3.3364	2.6247	3.1244	3.1302	3.0775	2.9566	-2.8663
Probability	0.0037	0.0172	0.0059	0.0058	0.0065	0.0084	0.0103
Change Post-1994	0.1844	0.4029*	0.2006*	0.1151	0.0545	0.7450*	-0.0126
t-statistic	1.6835	1.7735	1.9114	1.7113	1.5488	1.8956	-1.5282
Probability	0.1095	0.0931	0.0720	0.1042	0.1388	0.0742	0.1439
Currency premium:							
Pre-1994	-0.0026	-0.0040*	-0.0017	-0.0017	-0.0009	-0.0026	0.0000
t-statistic	-1.3430	-1.8583	-0.8509	-1.1439	-0.8576	-0.9322	0.0158
Probability	0.1960	0.0796	0.4060	0.2676	0.4024	0.3636	0.9875
Change Post-1994	0.0036	0.0094	0.0032	0.0017	0.0006	0.0016	0.0009
t-statistic	0.5411	1.0359	0.4869	0.4268	0.2000	0.1022	0.4061
Probability	0.5951	0.3140	0.6322	0.6746	0.8437	0.9198	0.6894

*** indicates 1% significance, ** indicates 5% significance, * indicates 10% significance level.

Table 10
Average Prices of Risks During Shocks

The table contains the parameter estimates of the regressions of the outliers (top 5% and bottom 5%) of the estimated prices of the market and currency risks on a constant and a dummy variable for the post-January 1994 period (D_t=1, if t > January 1994, and D_t=0 otherwise). Standard errors are computed using the Newey-West heteroskedasticity and autocorrelation robust procedure.

	Price of Market Risk	Price of Currency Risk
Pre-1994	3.5150[***]	1.5904
t-stats	8.8545	1.1029
Prob.	0.0000	0.2713
Change Post-1994	0.8655	0.8083
t-stats	0.7993	0.3645
Prob.	0.4250	0.7159

[***] indicates 1% significance, [**] indicates 5% significance, [*] indicates 10% significance level.

Table 11
Average Exposures at During Shocks

The table contains the parameter estimates of the regressions of the outliers (top 5% and bottom 5%) of the estimated conditional covariances of the returns with the market and currency index from the model with time-varying risk on a constant and a dummy variables for the post-January 1994 period (D_t=1, if t > January 1994, and D_t=0 otherwise). Standard errors are computed using the Newey-West heteroskedasticity and autocorrelation robust procedure.

	Metals and Mining	Oil and Gas	Industrial Products	Conglomerates	Consumer Products	Market Index	Currency
Market exposure:							
Pre-1994	0.0041[***]	0.0040[**]	0.0047[***]	0.0027[***]	0.0027[***]	0.0062[***]	-0.0003[***]
t-stats	2.8954	2.6745	4.0691	3.5786	4.7232	4.4938	-4.8112
Prob.	0.0096	0.0155	0.0007	0.0021	0.0002	0.0003	0.0001
Change Post-1994	0.0590[*]	0.1625[*]	0.0687[*]	0.0306[*]	0.0111[*]	0.2258[*]	-0.0031[*]
t-stats	1.7882	1.7811	2.0315	1.7840	1.8922	1.8891	-2.0640
Prob.	0.0906	0.0918	0.0572	0.0913	0.0747	0.0751	0.0537
Currency exposure:							
Pre-1994	-0.0002[**]	-0.0001	-0.0002[***]	-0.0002[**]	-0.0001[***]	-0.0003[***]	0.0001[***]
t-stats	-2.6432	-1.2806	-2.9149	-2.5941	-4.7440	-4.8112	21.4903
Prob.	0.0165	0.2166	0.0092	0.0183	0.0002	0.0001	0.0000
Change Post-1994	-0.0007	-0.0019[**]	-0.0010[**]	-0.0005	-0.0002[*]	-0.0031[*]	0.0000
t-stats	-1.7086	-1.8647	-2.1612	-1.6777	-1.7967	-2.0640	1.1589
Prob.	0.1047	0.0786	0.0444	0.1107	0.0892	0.0537	0.2616

[***] indicates 1% significance, [**] indicates 5% significance, [*] indicates 10% significance level.

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END NOTES

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[i] See for example Thompson (1994) and Obstfeld (1994)..

[ii] Engle (2002) provides a comprehensive survey of literature on GARCH modeling. Gourieroux and Jasiak (2001) and Tsay (2002) present a survey of several versions of MGARCH models. Engle and Kroner (1995) refer to the model used in Baba et al. (1990) as BEKK.

[iii] Vech representation uses the lower part of the variance-covariance matrix **H** in the vector form; diagonal representation restricts elements of **H** to depend only on parameters with the same coefficient indices.

[iv] CFMRC stands for Canadian Financial Market Research Centre.

[v] Given Canada's heavy reliance on trade with the U.S., the exchange rate used here is the exchange rate of Canadian dollar vis-à-vis US dollar.

[vi] See De Santis and Gerard (1998).

[vii] A refinement of BHHH (Bernt, Hall, Hall and Hausman (1974)) algorithm, see EViews 4.1 manual.

[viii] Data series on Canadian bonds, originally compiled by Scotia-McLeod, reported in CANSIM database is discontinued in April, 2002.

[ix] Aaa-rated bond yields are not available over the entire period of our study.

[x] As a robustness test, we also conduct the estimation with the value-weighted index and obtain similar results.

[xi] Statistical insignificance of some of the mean equation coefficients may be due to multicolinearity given the high level of correlations between some of the variables reported in Tables 1 and 2. However, the results of Likelihood Ratio test of joint hypotheses, reported in Table 5, indicate that the prices of market and currency risks are simultaneously equal to zero is rejected.

[xii] Hodrick-Prescott filter is a smoothing algorithm designed to reduce the noise in the estimated signal. See Hodrick and Prescott (1997).

[xiii] We do not present descriptive statistics for the estimated risk premia here; they are available on request from the authors.

[xiv] We aim to measure the ranges of values for the estimated risk premia and at the same time try to mitigate the impact of estimation errors. This is why we do not just present maximum and minimum values for the estimated risk premia, but use medians of the top and bottom deciles.

[xv] We believe this effect is due to increased market interdependence as government controls over cross-border capital flows are gradually removed. See Forbes and Rigobon (2002) for evidence on stock market interdependence.

[xvi] January 1, 1994 is the day when NAFTA came into effect. It is recognized that not only NAFTA, but also many other international events, such as FTA of 1987, and introduction of Euro are parts of a general trend towards globalization and deregulation of financial markets. We consider NAFTA to be a key event in the integration of Canadian economy with the other North American economies. Choice of the time of introduction of NAFTA as a break point to divide our study period into two sub-periods is somewhat arbitrary. We consider globalization as an ongoing process, and introduction of NAFTA to be an important landmark in that process. Therefore, by dividing the sample into pre-NAFTA and post-NAFA sub-samples, we in effect study whether the characteristics of the Canadian stock market changed as the process of globalization progressed, and we do not claim that NAFTA *alone* was the cause of such changes.

[xvii] We also find no significant changes in the average prices of market and currency risks, as well as in the average market and currency exposures. We do not present these results here but they are available upon request from the authors.

[xviii] Economic shocks from events such as the Asian currency crisis in 1998 did not have lasting effects in Canada.