TESTS OF FINANCIAL INTEGRATION:

Finite Sample Motivated Methods*

Beaulieu, Marie-Claude[§], Gagnon Marie-Hélène[¥] and Khalaf, Lynda[®]

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[§] Centre Interuniversitaire sur le Risque, les politiques économiques et l'emploi (CIRPÉE), CIRANO, and Département de Finance et Assurance, Université Laval. Mailing Address : Département de Finance et Assurance, Pavillon Palassis-Prince, Université Laval, Ste-Foy, Québec, Canada G1K 7P4. TEL 1 (418) 656 2926, FAX 1 (418) 656 2624; e-mail; Marie-Claude.Beaulieu@fas.ulaval.ca

[®]Canada Research Chair Holder (Environmental and Financial Econometrics Analysis), Centre Interuniversitaire de Recherche en Économie Quantitative (CIREQ), Groupe de Recherche en Économie de l'Énergie, de l'Environnement et des Ressources Naturelles (GREEN), and Département d'Économique, Université Laval. Mailing address : Département d'Économique, Université Laval, Pavillon J.A. De Sève, Ste-Foy, Québec, Canada, G1K 7P4. TEL : 1 (418) 656 2409; FAX : 1 (418) 656 7412; e-mail : lynda.khalaf@ecn.ulaval.ca

[¥] Institut de Finance Mathématique de Montréal (IFM2), Centre Inter universitaire sur le Risque, les politiques économiques et l'emploi (CIRPÉE), Groupe de Recherche en Économie de l'Énergie, de l'Environnement et des Ressources Naturelles (GREEN), and Ph.D Student, Département de Finance et Assurance, Université Laval. TEL 1 (418) 656-5828; e-mail : maryhgagnon@yahoo.ca

Abstract

This paper examines financial market integration in North-America from January 1984 to December 2003, using two basic CAPM and APT test models. We introduce a methodology valid in finite samples for the CAPM model. A pivotal statistic is introduced to correct for the so-called dimensionality curse which affects the critical points of the LR test statistic under the null hypothesis. When using this methodology, the null hypothesis of integration is strongly rejected for all sub-periods. Our results differ from those obtained in previous studies such as Mittoo (1992) using an asymptotic methodology. Next, an APT model with pre specified factors is used in order to test the null hypothesis of integration. The factors used are the Fama and French factors. In the latter two-pass test context, we introduce a split sample methodology in order to correct for the pre-estimation of BETAS. Moreover, we consider (and form) Fama and French factors for Canada for the 1984-2003 period. With this methodology, we again strongly reject the hypothesis of integration except for two sub-periods. Fama and French factors appear to have a different effect on the Canadian and American stock returns.

Introduction

This paper re-examines the integration of the Canadian and U.S. stock markets. Financial market integration is a relevant research interest given the present international globalization trends. Examples include the European Union and the NAFTA (North American Free Trade Agreement) in both Americas.

Valid assessments of integration require, first and foremost, a clear understanding of the phenomenon, which yields a "testable" definition. Indeed, despite a widespread use of the term "market integration" in the media and academia, a precise and formal definition of the concept is not readily available. Nevertheless, at least two research questions have been identified in this regard: (i) to quantify the positive and negative effects of such a change in the economy in general, and (ii) to adjust economic theory and methods in accordance with this new reality.

Classical international finance theory typically predicts that market integration will be beneficial for: (i) stockholders (integration expands asset diversification opportunities which improves risk management), and (ii) firms (integration allows to decrease the cost of capital). For example, Errunza and Miller (2000) quantify a substantial reduction in the cost of capital and consequently, the risk premium for firms who use ADRs (American Depository Receipt).

The contribution we make in this paper is empirical. First, we focus on financial market integration between Canada and the United States. For this purpose, we rely on two fundamental asset pricing models: the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). Several formal studies of market integration (which we will briefly review in what follows) are conducted via international asset pricing models. However, our literature review has revealed the need to revisit the applied econometric techniques in this context. While the financial literature on portfolio efficiency for example (see the reviews in Dufour and Khalaf (2002), Beaulieu, Dufour and Khalaf (2004a), and Campbell, Lo and MacKinlay (1997, chapter 5), Shanken (1996)) has long made fruitful use of econometric developments, in the context of financial market integration, interest in econometric improvements is, by contrast, relatively limited. Our goal is to introduce and apply finite sample motivated econometric methods to assess integration in CAPM and APT contexts, in order to obtain statistically more reliable results.

This paper is organized as follows. *First,* a brief survey of the literature on financial market integration (with focus on North American markets) is presented. *Second,* we summarize the two models of interest as formulated in Mittoo (1992): an international CAPM model and an APT model. *Third,* our modifications to the tests originally proposed by Mittoo (1992) are presented; we also justify the econometric adjustments and improvements we introduce. Specifically, we propose to correct the CAPM based tests for over-rejection problems caused by the so-called "dimensionality curse". In addition, we propose to correct the APT based tests for the error-in-variable problem associated with pre-estimated *betas.* In the first case, we introduce a finite sample *bound* on the null distribution of the test statistic (see Dufour and Khalaf (2002), Beaulieu, Dufour and Khalaf (2004b), Campbell, Lo and MacKinlay (1997, chapter 5) and Shanken (1986, 1996)); this bound is new even in Gaussian based integration tests. In the second case, we consider split sample techniques (see Dufour (2003), Dufour and Jasiak (2001) and the references cited therein), a simple method whose worth has been recently demonstrated in the econometric literature on weak instruments (see the survey in Dufour (2003)). *Fourth,* we present our test data base.[1] *Fifth*, we report our empirical analysis. A brief concluding section is devoted, in addition to a summary of our contributions, to the limitations of our present analysis which raise useful questions for further research.

[1] The construction of Fama-French type portfolios and factors for Canada is a major contribution of this thesis.

Part I

Review of literature

The present survey is not intended as an overview of the general literature on market integration; we rather consider the North-American case, with a specific focus on the econometric methods applied to this problem in published work.

Market integration tests first show up in the literature in the early 80s, following regulatory changes on international capital flows and resulting increased capital mobility. Stehle (1977) presents one of the first studies on the integration of the American market vis-à-vis the international market. Unfortunately, it is now recognized that rejection of integration as reported by the author is due to serious co-linearity between the two markets at study.

On the Canadian case, Jorion and Schwartz (1985) provide one the first formal studies; their work has led to several published articles along the same line of work (surveyed in Mittoo (1992)). Jorion and Schwartz test integration and/or segmentation of the Canadian market vis-à-vis the American market. In addition, their study presents one of first formal definitions for market integration: *markets are integrated when assets with similar risk on the two different markets obtain the same return on their respective markets.* Moreover, to formulate a testable version of the latter definition, they use a Multivariate Linear Regression (MLR) based CAPM framework, where integration (or segmentation) yield non-linear constraints estimable and testable via maximum likelihood procedures. The underlying intuition is the following: if markets are segmented, the only risk factor that should be rewarded is the one representing the Canadian market index. Inversely, if markets are integrated, the global market index is the only factor that should be significant. They use a sample of 749 companies traded on Toronto Stock Exchange for the period of

1963-1982. Results (based on asymptotic although Likelihood based procedures) strongly reject integration for the whole period for all portfolios formed. Three subsequent influential studies are noteworthy for the Canadian case: Errunza, Losq and Padmanabhan (1992), Mittoo (1993) and Koutoulas and Kryzanowski (1994).

Errunza, Losq and Padmanabhan (1992) formulate and test (via a maximum likelihood procedure) three hypotheses: integration, mild segmentation and segmentation. Tests are conducted over a group of eight developing countries and on Canada vis-à-vis the American market. The data used are the monthly returns and dividends of 871 assets for developing countries and 20 Canadian assets for the 1975-1987 period. Results for both developing countries and Canada suggest a non-polar market structure, which means that markets are not fully integrated and not fully segmented. However, results seem to show that Canada is more integrated than segmented and the developing countries are more segmented than integrated.

Mittoo (1993) formulates and tests (via a maximum likelihood procedure) integration in the context of two asset pricing frameworks (the CAPM and APT) and across various sub-periods. Results show that markets tend, over time, to be more integrated. Integration is rejected for the first sub-period and for the whole sample period, but not in the second sub-period. Results also indicate that inter-listed stocks seem to be more integrated than non inter-listed ones. The present paper is based on the tests developed in Mittoo (1993), which we will explain in detail in Part II of this document.

Koutoulas and Kryzanowski (1994) study the Canadian financial market integration vis-à-vis the American market using an APT framework (based on macro-economic factors). In order to specify relevant risk factors, they refer to the exchange rate determination literature. The econometric approach used in order to test for market integration and segmentation is a SURE system with linear equations. The data used are monthly returns on all stocks traded on Toronto Stock Market for the 1969 - 1988 period. Stocks are sorted in ascending order with respect to size to form 50 portfolios of Canadian assets. The macro economic factors used in the study are obtained from Statistic Canada. Results show that: (i) the Canadian market is partially integrated, (ii) Canadian stock returns are influenced by a few domestic factors (such as term structure and the lagged industrial production level) and by some international factors (such as the Eurodollar rate).

Another important reference for this paper (from a methodological perspective) is Gultekin, Gultekin and Penati (1989). It is worth noting that the Japanese market provides an interesting experimental special case, because a radical market liberalisation took place in December of 1980: the Nippon government then adopted new regulations that made international commerce much easier. Gultekin, Gultekin and Penati (1989) assess, via a multifactor APT framework, the degree of integration of the Japanese market vis-à-vis the American market. To do so, they provide an interesting definition of market integration related to a multifactor approach: *markets are integrated if assets from two countries showing perfectly correlated returns are priced the same way regardless of the country where they are traded.* In this context, segmentation is due to capital flow barriers and investors irrationality. The data used are the monthly return of 220 assets from United States and Japan for the 1977-1984 period, assumed to be representative of both economies. Moreover, four international risk factors and two purely domestic risk factors are selected for each country. The integration hypothesis is tested on the multifactor APT model for two sub periods: before and after the legislation. Results suggest that markets were segmented before December 1980 but that it was less the case following the legislation. These results indicate that segmentation in financial markets could be mainly attributed to government policies. This study is particularly interesting in the view of our present work because its econometric method is multi factor based with a split sample type methodology. Interestingly, this study provides one of the first (informal) applications of the later methodology in finance. Despite the fact that the problem of pre-estimating *betas* in two-pass regression based tests in finance is still a major research concern (see Chen and Kan (2004)), split sample based solutions to this problem have received limited interest (relative to their popularity in the weak instruments econometric literature).[2] In this paper, the method we use to correct for error-in-variables is based on sample splits, although we consider a splitting procedure which differs from Gultekin *et al.* (1989). Related results on the integration of the Nippon market can be found in Campbell and Hamao (1992). These authors use a multifactor APT framework with different macroeconomic risk factors, such as the US risk free rate (T-bill rate) and the dividend yield on American financial assets. Results show that the latter non-domestic factors have a predictive power for Japanese returns in the 80s. This accords with the findings of Gultekin *et al.* (1989).

In general, the above surveyed studies suggest that: (i) integration is empirically upheld in post-80s samples, and is rejected prior to the 80's; (ii) markets are however not fully integrated nor fully segmented; (iii) a tendency toward integration is observed over time, although recent studies on this issue for the case of Canada are not prevalent. One of the contributions of this paper will be to test integration over a recent post-80s sample; specifically we consider monthly data from 1984 to 2003. Since test results on integration are not stable over time, an analysis over relatively short time spans is clearly called for. For instance, it is common practice to consider five year sub-periods and monthly data; in other words, the size of standard test samples is around 60 observations. Given that the econometric models underlying the tests are multivariate, asymptotic procedures in such contexts are known to be highly unreliable and to lead to serious over-rejections. We propose to apply finite sample motivated test procedures in both APT and CAPM frameworks.

We next proceed to present in more details Mittoo's (1992) test procedures which form the basis for our proposed approach in the present paper.

[2] The underling statistical problems in both cases are different, although related via the error-in-variable difficulty. Available results from the IV-regression literature are not readily applicable to two-pass regressions, but may provide serious motivational arguments. Simulation studies or theoretical contributions on the split-sample approach to two-pass regressions are a worthy research objective, given its popularity in financial applications.

Part II

The Theoretical Models

The two theoretical and empirical models that will be used in this paper are derived from Mittoo (1992). In this paper, market integration in North-America during the 1977-1986 period is studied. This period was characterized by trade liberalisation in North-America. Stocks considered in the study are those included in the TSE 35 in May 1987; the latter present many advantages. First, they correspond to big companies and are not subject to thin trading, a frequent problem in Canadian data. In order to control for possible industries bias, bank stocks and minerals were taken out of the sample. Three theoretical models are used to test integration: (1) the Capital Asset Princing Model (CAPM); (2) an Arbitrage Pricing Theory (APT) with pre- specified factors and an APT model with factor analysis. In this paper, only the first two models will be used.

The CAPM model

Mittoo (1992) sets out the following basic CAPM theoretical model:

$$E(R_i) - R_F = \gamma_0 + \gamma_1 \beta_i \qquad (1)$$

where $E(R_i)$ represents the expected return of asset i, R_F is the risk free rate,

β_i = covariance (R_i , R_M) / variance (R_M)

represents the asset's BETA (the systematic risk associated with the asset), γ_0 is the difference between the expected return of the zero-BETA portfolio and the risk free rate (see Black (1972)) for which γ_1 is given by $E(R_M)$- R_F -γ_0.

The first step in order to test market integration is to isolate the purely domestic component which is independent of the integrated market. To do this, Mittoo (1992) proposes a projection of the domestic market index on the integrated market index:

$$R_D - R_F = \alpha_0 + \alpha_1 (R_I - R_F) + V_{D-I} \tag{2}$$

where R_D is the weight adjusted Canadian market index, R_I is the weight adjusted combined index for the Canadian and American markets (in what follows, we refer to R_I as the so called *integrated market index*), R_F is the risk free rate (as defined above), and the residual V_{D-I} represents the fraction of the risk premium that can be associated solely to the domestic market[3]. Then, an integrated version of the CAPM model can be written by adding this new component:

$$E(R_i) - R_F = \gamma_0^I + \gamma_1^I \beta_i^I + \gamma_2^{D-I} \beta_i^{D-I} \tag{3}$$

where γ_1^I is the coefficient associated to the systematic risk of the integrated market [β_I^I], γ_2^{D-I} is the coefficient associated to the domestic systematic risk.

For a sample of T observations on the returns of N portfolios, the theoretical model presented in (3) gives the following empirical model:

$$R_{it} - R_{Ft} = E(R_{it}) - R_{Ft} + \beta_i^I (R_{It} - E(R_{It})) + \beta_i^{D-I} V_{(D-I)t} + e_{it}^I \tag{4}$$

where e_{it}^I is the error term assumed to be normal with mean zero; R_{it} and $E(R_{it})$ represent respectively the observed and expected return of asset i at date t; $V_{(D-I)t}$ is the residual associated to the domestic risk premium at time t (obtained by a preliminary regression of the domestic excess return index on the integrated excess return index as in equation (2));

[3] Note that the use of this variable for the domestic risk premium eliminates the co-linearity problem between the two markets, a problem that plagued Stehle's (1977) study.

R_{Ft} is the risk free rate at time t. In this paper, the data for the Canadian and American markets and the risk free rate are extracted in U.S dollars from Datastream. The excess returns on the portfolios used are six portfolios formed according to size and book to market retrieved from Kenneth R. French web site. Part III will develop in detail their formation and the data used to obtain them.

Substituting (3) in (4) et setting $\gamma_I = E(R_{It}) - R_{Ft} - \gamma_0^I$, the equation of interest is given by:

$$R_{it} - R_{Ft} = \gamma_0^I (1 - \beta_i^I) + \gamma_2^{D-I} \beta_i^{D-I} + \beta_i^I (R_{It} - R_{Ft}) + \beta_i^{D-I} V_{(D-I)t} + e_{it}^I \quad .(5)$$

In the last equation, the parameter of interest, γ_0^I, γ_2^{D-I}, β_i^I, and β_I^{D-I}, are estimated jointly by a maximum likelihood procedure on a SURE system of equations under a non linear constraint.

As for the segmentation test, it is done in the same statistical context. The equation of interest is obtained by inter changing the domestic and integrated index in equation (2) to (5):

$$R_{it} - R_{Ft} = \gamma_0^D (1 - \beta_i^D) + \gamma_2^{I-D} \beta_i^{I-D} + \beta_i^D (R_{Dt} - R_{Ft}) + \beta_i^{I-D} V_{(I-D)t} + e_{it}^D \quad . (6)$$

In the integration test, the null hypothesis and its alternative are:

$$H_0^{CAPM} : \gamma_2^{D-I} = 0$$
$$H_A^{CAPM} : \gamma_2^{D-I} \neq 0 .$$

In this context, a rejection of the null hypothesis implies segmentation. If the null hypothesis is not rejected, the model reverts to a standard international CAPM model since the domestic factor does not bear any not explanatory power. As for the segmentation test, the null and alternative hypotheses are:

$$H_0^{CAPM}: \gamma_2^{I\text{-}D} = 0$$
$$H_A^{CAPM}: \gamma_2^{I\text{-}D} \neq 0.$$

In this case a rejection of the null hypothesis would imply integration. In fact, the international component of risk $V_{(I\text{-}D)t}$ would then be significant. If the null hypothesis is rejected however, the model is a standard domestic CAPM.

In the context of Mittoo (1992) an asymptotic student test is used to assess the null hypothesis. It is the later point that we aim to revisit. Indeed, it is known that the null distribution of classical statistical tests (including the student test) in the multivariate regression model at hand is poorly approximated by a χ^2 distribution (see Campbell, Lo and Mackinley (1997), chapter 5). More concretely, the tests critical points are either over estimated or under estimated. In fact, as the number of portfolios and the number of equations increase, the dimension of the variance-covariance matrix (which needs to be estimated) increases very rapidly. Degrees of freedom are reduced and precision of the test is strongly affected. This problem is known in the literature as the "Dimensionality Curse". It is then very probable to reject the null hypothesis spuriously using the standard t-test.

Our solution to this problem proceeds as follows. First, we consider a Likelihood-Ratio [LR] type statistic and provide a corrected critical point as an alternative to the asymptotic one. To do so, we derive a *pivotal* bound on the null distribution of the LR statistic. A statistic is *pivotal* if its distribution is known (free of nuisance parameters) under the null hypothesis. Since the null hypothesis is non-linear, our LR statistic is not pivotal, but we show that it can be bounded by a pivotal one. To obtain this bound, we will use the statistical methodology presented in Dufour and Khalaf (2002) and Beaulieu, Dufour and Khalaf (2004b) (see also Shanken (1986)): we introduce a hypothesis H_{0Bound} formulated so that: (i) it is a special case of the restriction to be tested, and (ii) its associated LR criterion is pivotal.

To motivate our bounding procedure, consider the unconstrained linear CAPM model:

$$R_{it} - R_{ft} = \alpha_i + \beta_i^I (R_{It} - R_{Ft}) + \beta_i^{D-I} V_{(D-I)t} + e_{it}^I \tag{7}$$

where variables retain the same definition as in (5), and α_i is the intercept of equation i. In this case, the intercepts are unrestricted. The alternative hypothesis associated with our integration tests corresponds to the latter model imposing Black's CAPM constraint on the intercept:

$$\alpha_i = \gamma_0^I (1 - \beta_i^I) \tag{H_{02}}$$

where γ_0^I is unknown. When we impose the null hypothesis of integration on equation (7), the intercept is further constrained as follows:

$$\alpha_i = \gamma_0^I (1 - \beta_i^I) + \gamma_2^{D-I} \beta_i^{D-I} \tag{H_{03}}$$

where both γ_0^I and γ_2^{D-I} are unknown. In order to obtain a pivotal statistic under the null hypothesis of integration, we need to consider the special case of H_{03} where both γ_0^I and γ_2^{D-I} are set to known values:

$$\alpha_i = \gamma_{0B}^I (1 - \beta_i^I) + \gamma_{2B}^{D-I} \beta_i^{D-I} \tag{H_{0B}}$$

but with both γ_{0B}^I and γ_{2B}^{D-I} known. By construction, H_{0B} is a special case of (H_{03}). In addition, H_{0B} has a specific *uniform linear* form: in this case, the LR statistic to test H_{0B} against the completely unrestricted model (7) is pivotal [see Dufour and Khalaf (2002)]; in fact, if the errors are normal, a monotonic transformation of this LR statistic (which we will call "the bounding statistic") follows an F-distribution (with known degrees of freedom) under the null hypothesis. H_{0B} thus serves our purpose as a bounding hypothesis because: (i) it is a special case of the restriction to be tested, and (ii) its associated LR criterion is pivotal.

Formally, the statistic we propose as alternative to the t-based one used in Mittoo (1992) is:

$$LR = 2*[L_2 - L_3]$$

where L_2 and L_3 are the natural logarithm of the determinant of the maximum likelihood estimate of the error variance-covariance matrix of model (7) imposing, respectively, Black's constrain (H_{02}), and the integration hypothesis (H_{03}). We also introduce another statistic which as will become clear in what follows, admits the same bound as LR yet is *closer* to the this bound (*i.e.* promises better power):

$$LR_u = 2*[L_1 - L_3]$$

where L_3 is as defined above and L_1 is *the natural logarithm of the determinant of the unconstrained maximum likelihood estimate of the error variance-covariance matrix* of model (7). Since L_2 corresponds to a constrained maximization relative to L_1, then (because a constrained maximum is always less than or equal to the unconstrained maximum):

$$LR \leq LR_u \, . \tag{8}$$

Moreover, the LR statistic associated with the bound null hypothesis is:

$$LR_{Bound} = 2*[\, L_1 - L_B]$$

where L_1 is as defined above and L_B is *the natural logarithm of the determinant of the maximum likelihood estimate of the error variance-covariance matrix* of model (7) imposing the bounding null hypothesis, (H_{0B}). Since L_B corresponds to a constrained maximization relative to L_3, obviously $L_B \leq L_3$; it follows that:

$$LR_u \leq LR_{Bound} \, . \tag{9}$$

Combining (8) and (9) implies:

$$LR \leq LR_u \leq LR_{Bound} \, . \qquad (10)$$

In addition, from Dufour and Khalaf (2002), a monotonic transformation of LR_{Bound} has a known null distribution:

$$F_{Bound} = ((T\text{-}(K\text{-}1)\text{-}N) / (N)) \; (\exp((LR_{Bound} / T)) - 1) \sim F\,(N, T\text{-}(K\text{-}1)\text{-}N)$$

where K is the number of regressors (including the intercepts) in the unconstrained regression (7), and N is the number of equations in the system (as defined above). The latter result holds exactly (for finite T, as long as T-(K-1)-N remains positive).

At this stage, a brief intuitive analysis of the above procedure is useful. For a test of significance level α, based on LR or LR_u, if we use the bounding critical point at level α (*i.e.* the F (N, T-(K-1)-N, α) cut-off) rather than the standard asymptotically justified Chi-Square one, we improve type I error control, as is illustrated in Figures 1-2. In Figure 1, the curve which illustrates the null distribution of LR_{Bound} bounds the null distribution of LR because of inequality (10). So if the cut-off point *c* is chosen in such a way that

$$P\,(\mathrm{LR}_{\mathrm{Bound}} \geq c) = \alpha$$

(i.e. the area under the curve which illustrates the bounding distribution under the null is equal to α), then

$$P\,(LR \geq c) \leq P\,(LR_{Bound} \geq c) = \alpha$$

so

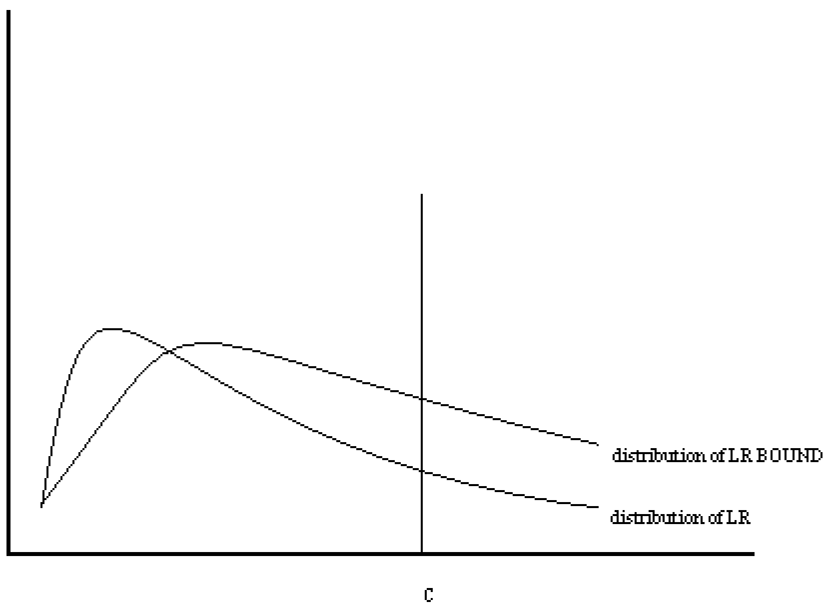
$$P\,(LR \geq c) \leq \alpha$$

and this implies (by the definition of a level-correct test) that the bound based test achieves level (i.e. Type I error) control. The problem of the asymptotic cut-off point is that it is based on a poor approximation, so relying on it <u>cannot</u> guarantee that under the null hypothesis:

$$P\,(\,LR \geq asymptotic \quad cut - off\,) \leq \alpha$$

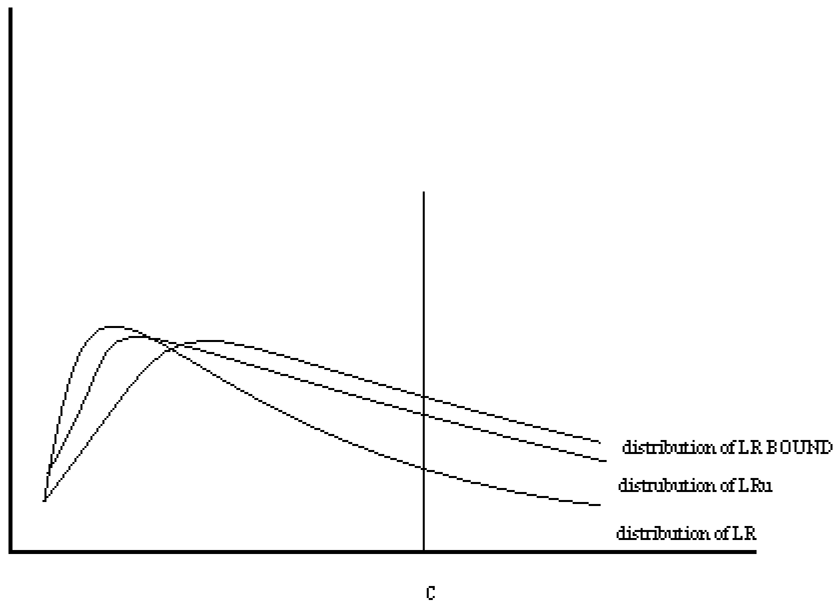
in finite samples, so its associated Type I error may be larger than the nominal level α, which implies spurious rejections.

Figure 1- The null distribution of the proposed LR and bounding statistics



It is now easy to see why a more powerful test can be obtained if we rely on LR_u. Figure 2 illustrates the null distribution of $LR \leq LR_u \leq LR_{Bound}$. Because LR_u is "closer" to the bounding statistic, the chance to reject the null hypothesis (using the bounds cut-off) is higher if we use LR_u rather than LR, with obvious implications on test power. Moreover, recall that the integration null hypothesis is a joint hypothesis which imposes BLACK's CAPM and integration; so relying on LR_u (which corresponds to the least constrained alternative hypothesis) may provide further information on the model underlying the tests.

Figure 2- The null distribution of the two proposed LR and bounding statistics



The APT model with pre-specified factors

The APT theory assumes that several risk factors intervene in the evaluation of an asset. The basic APT model is the following:

$$R_{it} = E_{it} + \sum_{k=1}^{s} \beta_{ik} \delta_{kt} + u_{it} \quad (11)$$

where R_{it} and E_{it} represent respectively the actual and expected return of asset i at time t; δ_{kt} is the k^{th} risk factor at time t; β_{ik} is the sensitivity of asset i to risk factor k and finally, u_{it} is the error term at time t (which is often assumed to be normal with mean zero). In order to test integration within the latter model, similar portfolios from Canada and United States will be evaluated. If markets are integrated, it implies that similar assets respond in a similar way (in the same magnitude) to the same risk factors.

If there are no arbitrage possibilities, the expected return of an asset can be written as a linear function of the risk factors sensitivities:

$$E_{it} = R_{Ft} + \sum_{k=1}^{s} \lambda_k \beta_{ik} \quad (12)$$

where R_{Ft} is a scalar representing the risk free rate at time t; λ_k is the risk premium associated with risk factor k and β_{ik} (as defined above) is the sensitivity of asset i to risk factor k.

Combining equations (7) and (8) will generate the empirical model of interest:

$$R_{it}^{J} = R_{Ft}^{J} + \sum_{k=1}^{s} \lambda_k^{J} \beta_{ik}^{J} + e_{it}^{J} \quad (13)$$

with an error term :

$$e_{it}^{J} = \sum_{k=1}^{s} \beta_{ik} \delta_{kt} + u_{it}$$

where J = (CND) , (US) refers respectively to Canada and United States; in other words, the return of asset i [Canadian or American] at time t is the scalar R_{it}^{J}, the risk free rate [Canadian or American] is the scalar R_{Ft}^{J} , λ_k^J is the risk premium for the kth risk factor [Canadian or American], β_{ik}^{J} represents the sensitivity of asset i [Canadian or American] to factor k at time t. The composition of the error term is due to the fact that factors are not observable. Moreover, the American dollar is always used as a numeraire.

Testing integration thus involves a joint null hypothesis:

$$H_0^{APT} : \lambda_k^{CDN} = \lambda_k^{US} \text{ and } R_F^{CDN} = R_F^{US}.$$

This hypothesis implies that the risk premium associated to each k factor and the risk free rate are the same in the two different countries. The alternative hypothesis is:

$$H_A^{APT} : \lambda_k^{CDN} \neq \lambda_k^{US} \text{ or } R_F^{CDN} \neq R_F^{US} .$$

A rejection of the null hypothesis would imply market segmentation since similar assets will not be priced in the same way in different countries.

In the context of the APT model, the choice of risk factors is a very important step. Mittoo (1992) selects a set of five macroeconomic factors: the difference in short term interest rates, the risk premium, the term structure, industrial production and the return on the integrated market. This paper will deviate from Mittoo's approach in the choice of factors. We have opted for Fama and French factors (see Fama and French (1993)). Our choice was motivated in the most part by the current trend in the financial literature. Indeed, the use of financial factors seems to have gained popularity. We construct three Fama-French type factors: SMB, a factor related to size, HML, a factor related to book to market ratio and the market factor. In fact, these factors are expected to proxy the common risk factors in asset pricing. The size of a company is related to its profitability since small firms tend to have lower earnings on assets than big firms. There seems to be a negative relation between size and average return, especially in the 80s. The SMB (small minus big) factor is the difference between the return of portfolios constituted of small firms and portfolios constituted of big firms. As for the book to market ratio, firms that have a high BE/ME ratio (a low stock price compared to its book value) tend to have low earnings. Inversely, low BE/ME firms (a high stock price relative to book value) are associated with high earnings. The HML (high minus low) factor is the differential between portfolios constituted of high BE/ME ratio and portfolios constituted of low BE/ME ratio. The market factor is a portfolio that mimics the return on the domestic market. The construction of the Fama and French factors will be discussed in detail in part III.

The empirical problem of the APT model is that the "BETAS" are not observable but estimated with error. Typically in this case, it is necessary to adopt a two steps procedure: (1) estimate the assets sensitivity to the risk factor (the "BETAS") and (2) evaluate the risk premium λ associated to each risk factor. In Mittoo (1992), the same sample of observation is used for the two steps. The BETAS are obtained by regressing the assets return on the risk factor without a constant term (a standard APT model). Then, the risk premiums are estimated by a maximum likelihood procedure on the following SURE system of equations:

$$\overline{R_i^{CDN}} = R_F^{CDN} + \sum_{k=1}^{s} \hat{\beta}_{ik}^{CDN} \lambda_k^{CDN} + \upsilon_i^{CDN}$$

$$\overline{R_i^{US}} = R_F^{US} + \sum_{k=1}^{s} \hat{\beta}_{ik}^{US} \lambda_k^{US} + \upsilon_i^{US} \qquad (14)$$

where the dependent variables are the expected mean return of asset i over the whole period. Then Mittoo uses three test statistic to evaluate the null hypothesis: a Wald test, an Hotelling test and an adjusted Hotelling test (see Shanken (1985)) correcting for the pre-estimation of the BETAS.

A contribution of the present paper is to propose an alternative correction for the error in variables. Pre-estimating the *BETAS* leads to contemporaneous correlation between the regressors of (10) and its error terms, since the same sample is used to evaluate the parameters in both steps (the sensitivities and risk premiums). In order to bypass this problem, the econometric method that will be used here is the "split sample" (see Dufour (2003)). The split sample methodology was recently introduced in econometrics for a different (although related) test problem involving error-in-variables.[4] The intuition for this method is to use one part of the available sample to estimate the *BETAS* and the remaining part to evaluate the risk premium. It is usually recommend to save a larger sample for the second pass.

Different sample splits will be tested here. First, following Gultekin, Gultekin and Penati (1989), the first part of the sample will be used to estimate the *BETAS* and the second part to evaluate the risk premium. Two breakpoints will be tested; 30% and 40% of the sample used for BETAS and the remaining part for the risk premium. However, a problem with this approach is that *BETAS* are likely to change over time. Then, it is possible that *BETAS* estimated in the 1984-1989 sample period are not representative of the *BETAS* in 2000. A second type of split sample will be to use the observations of March, June, September and December of each year to estimate BETAS and the remaining months to estimate risk premiums. Finally, the third type of split sample we consider is to use the months of April, August and December of each year to estimate BETAS and the remaining months to estimate risk premiums. The split sample methodology will also be applied in sub-periods of five and ten years.

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[4] Formal proofs of its validity in a two-stage procedure involves the case where the fitted values of the first stage regression are used in the second stage; here, the second pass uses the estimated parameters (rather than the fitted values) from the first pass.

Part III

Data

Most of the data used in this paper were not readily available and had to be extracted and constructed. In this section, we present the methodology used to construct the database. Two different asset pricing models are used to test for financial market integration: the Capital Asset Pricing Model (CAPM) and a Multifactor Arbitrage Pricing Theory (APT). Since the data required for these two models are different, they will be treated in two distinct sections.

The Capital Asset Pricing Model (CAPM)

A test of integration is done using equation (5);

$$R_{it} - R_{Ft} = \gamma_0^I (1 - \beta_i^I) + \gamma_2^{D-I} \beta_i^{D-I} + \beta_i^I (R_{It} - R_{Ft}) + \beta_i^{D-I} V_{(D-I)t} + e_{it}^I$$

Similarly, a test for the hypothesis of market segmentation is based upon equation (6)

$$R_{it} - R_{Ft} = \gamma_0^D (1 - \beta_i^D) + \gamma_2^{I-D} \beta_i^{I-D} + \beta_i^D (R_{Dt} - R_{Ft}) + \beta_i^{I-D} V_{(I-D)t} + e_{it}^D$$

In order to test the integration and the segmentation hypotheses with the two CAPM models, five series are needed: the domestic market index excess return, the integrated market index excess return, purely domestic residuals, purely international residuals and Canadian portfolios excess returns. Our sample is composed of monthly data for a twenty year window starting in January 1984 and ending in December 2003. The domestic market index excess return used is the excess return on the TSE 300 index adjusted for dividend.

The index adjusted price for dividend was extracted from DataStream and the index monthly return was computed with the following formula:

$$return_t = \frac{price_t - price_{t-1}}{price_t} \times 100 \quad . \tag{15}$$

Furthermore, we need the Canadian risk free rate to calculate the domestic market index excess return. The Canadian one month T-bill rate was extracted from DataStream and used for the risk free rate. However, DataStream report the one-month T-bill in annual rate of return. The monthly return for the one-month T-bill was computed using the following formula:

$$\text{Monthly rate} = (1 + \text{annual rate})^{1/12} - 1 \quad . \tag{16}$$

Finally, the monthly domestic market index was obtained by subtracting the monthly risk free rate to the monthly return of the TSE 300.

A few extra steps are needed in order to compute the monthly-integrated market index. First, the American market monthly excess return is needed. This serie was obtained directly on Kenneth French's web site. On the site, the monthly market factor for the United States, which is the return of the American overall market minus the American one-month T-bill risk free rate was extracted. Next, the integrated market excess return needs to be adjusted for the size of the two financial markets of this study: Canada and the United States. In order to do that, the total capitalizations of both markets are extracted from DataStream. However, it is important to make sure that both capitalizations are in the same currency. In our study, the U.S dollar was selected as the basis currency. The total Canadian capitalization in U.S dollars is available on DataStream. The value weighted integrated market index was computed in the following way:

$$R^{INT} = R^{CAD} \left(Cap^{CAD} / (Cap^{US} + Cap^{CAD}) \right) + R^{US} \left(Cap^{US} / (Cap^{US} + Cap^{CAD}) \right) \tag{17}$$

Where R^{INT} is the value weithed return on the integrated market index, R^{CAD} and R^{US} are respectively the return on the Canadian and American market index and Cap^{US} and Cap^{CAD} are respectively the Canadian and American market capitalization.

Two ordinary least squares regressions with intercept are run in order to get the domestic and integrated residuals. First, the regression of the domestic market excess return on the integrated market excess return was done. The residuals of the regression are the purely domestic residuals used in the integration test, $V_{(D-I)t}$. Second, the regression of the integrated market excess return on the domestic market excess return was performed. Residuals from this regression are the purely integrated residuals used in the segmentation test, $V_{(I-D)t}$.

Regarding Canadian portfolio monthly excess returns, we chose to use six portfolios formed on size and book to market from Kenneth R. French web site to compute Fama and French factors (see Fama and French 1993). Given the relatively smaller number of firms in Canada compared to the United States, we decided to use six portfolios in this part of the analysis in order to have portfolios with a relatively large number of firms in each portfolio. The classification of stocks in the appropriate portfolio is done using two factors: the market equity value (ME) and the book-to-market ratio (BE/ME). The method followed in this paper is exactly the same as Fama and French (1993). First, accounting data are needed to compute the book-to-market ratio. The following formula is used to compute the book equity value (BE):

Book Value = Book Value of Stockholders Equity + Balance Sheet Deferred Taxes + Investment Tax Credit (if available) – Book Value of Preferred Stock. (18)

Since Book Value of Preferred Stocks is not a readily available series, depending on availability of the following accounting series, we used (in that order, given availability): redemption value, liquidation value and par value. To gather these data, we used the sample "$T_CAN" from Compustat. This sample contains all Canadian firms on Compustat. Then, the BE for all stocks in the sample was computed using equation (6). It is important to note that the BE/ME ratio is computed only once a year. The ratio at the end of the previous year (December of year t-1) is the BE/ME for year t. Stocks that did not have readily available information on BE for at least two consecutive years were eliminated from the sample as well as mutual funds (to avoid double counting), stocks that was not traded on the Toronto Stock Exchange, or stocks that were not ordinary shares. These conditions formed a sample of 961 stocks. Then, firm's capitalization and stock prices at the end of December at *t-1* were extracted from the TSE-Western for all 961 firms. Market equity was obtained by multiplying those two series. Finally, the BE/ME ratio was constructed by dividing the book value computed above (BE) by market value (ME).

Given that the sample includes information relative to BE/ME ratio and ME for every firm, the shares are then sorted into Fama and French portfolios. It is important to note that once the ranking of firms is done at December *t-1*, it remains the same for the whole year *t*. Within each year, we matched each monthly observation with its corresponding ME annual value and BE/ME annual ratio. Firms with a negative BE/ME ratio were eliminated from the year *t* sub-sample. Sorting of firms is then done on the following basis: first, all firms are ranked in ascending order with respect to their size (ME). Then, the sample is divided into two groups, the breakpoint being the median stock size. We then have one group containing firms whose size is inferior to the median size (small) and one group containing those stocks whose size is greater than the median size (big). As a convention, the median stock was always placed in the small firm sub sample. Each group was then sorted in ascending order with respect to the BE/ME ratio. Again, each group was divided, but in this case we created three sub groups. The first sub group was constituted of the first 30 % of the firms. Those had the lowest BE/ME ratio (low). The second sub group contained the middle 40 % of the group. Firms in that sub group have a medium ME/BE ratio (medium). Finally the last sub group contained the 30 % of the firm who had the highest ratio (high). This ranking was done on the two size groups: small and big. In the end, six different portfolios were formed: S/L, S/M, S/H, B/L, B/M, B/H. For example, portfolio S/L contains those stocks that are small in size and that have a low BE/ME ratio.

Once the stocks are assigned into the different portfolios, we computed value weighted monthly excess returns. First, the weight of each stock in the portfolio is computed. This weight is obtained by dividing the stock's monthly capitalization by the total monthly capitalization of the portfolio. Returns for each stock are multiplied by their weight. Weighted returns for each stocks are summed to get the value weighed monthly return of the portfolio. Finally, the Canadian one month T-bill rate is subtracted from all the observations to get the portfolio value weighed excess return. In the end, each portfolio has 240 monthly observations.

The Multifactor APT Model

The second empirical model used to test integration in this study is a multifactor APT model described in equation (9):

$$R_{it}^{J} = R_{Ft}^{J} + \sum_{k=1}^{s} \lambda_{k}^{J} \beta_{ik}^{J} + e_{it}^{J} \qquad (9)$$

In this context, data needed relate to Fama and French factors: the return on the market portfolio (RM), a factor related to size (SMB) and a factor related to the book-to-market ratio (HML) for Canada and the United States as well as the Canadian and American monthly risk free rate.

The six portfolios formed in the preceding CAPM model were used once again in order to computed the Fama and French factors. The SMB risk factor represents the risk premium associated with the size of the firm. This risk factor is obtained by subtracting the mean monthly return of the big portfolio (B/L, B/M, B/H) to the mean monthly return of the small portfolios (S/L, S/M, S/H). The formula used is the following:

SMB= [(r S/L + r S/M + r S/H) / 3] - [(r B/L + r B/M + r B/H) / 3] . (19)

where r represents the monthly return of the portfolio. The HML risk factor, the risk premium associated to the BE/ME ratio of the firm is obtained by a similar method. It is obtained by subtracting the mean monthly return of the low portfolios (S/L, B/L) to the mean monthly return of the high portfolios (S/H, B/H):

$$HML= [(r\ S/H + r\ B/H)/2] – [(r\ S/L + r\ B/L) / 2] . \quad (20)$$

Note that SMB and HML risk factors were computed only for Canada since the American factors were readily available on Kenneth French's web site.

We construct the Canadian market factor by computing the value weighed monthly return of all stocks included in our sample of 961 firms. The monthly total capitalization was computed and the weight of each firm was obtained by dividing the firm share monthly capitalization by the total monthly capitalization of all firms. Each stock return was then multiplied by its weight. Finally, all weighted returns were summed to obtain the monthly value weighted market return of the Canadian market. Again, the market factor for the United States was downloaded from Kenneth French's web site.

Returns on Canadian portfolios were obtained in a very similar way as the six portfolios used in the CAPM model. The same sample of 961 firms was used to form 25 portfolios following the Fama and French (1993) method. We used 25 portfolios in this part of the analysis given that results are averaged out and that using only six portfolios as in the CAPM section would have produced unreliable results. Once again, the ranking is done only once a year in December *t-1* so it is convenient to work with one year of data at the time. The negative BE/ME ratio firms are excluded from the year sample. Stocks are then sorted in ascending order with respect to their size. The sample must be divided in five sub-samples with respect to size (ME). The breakpoints are the 20,40,60,80 percentiles with the breakpoint stock always classified in the smallest percentile. Then, each sub-sample sorted by size must be re-divided with respect to the BE/ME ratio. The breakpoints are still the 20,40,60 and 80 percentiles of each sub sample with respect to the BE/ME ratio. Redoing this operation for each five sub-samples will generate 25 portfolios. The returns for each 25 portfolios are computed in the same way as before in value-weighted portfolios. The returns on the 25 American portfolios were taken from Kenneth French's web site.

Part IV

Results

The CAPM model

In this section, we present results for the test of integration and segmentation in the context of the CAPM. Results are reported in table I. Integration appears to be supported by the data when the asymptotic LR p-value is used for the decision. In fact, the p-value from the asymptotic LR following a χ^2 (5) is not significant at the 5% confidence level. This result is in accordance with Mittoo (1992) since she could not reject integration either with an asymptotic Wald test for the 1982-86 period of her study. It is comforting to see that integration is supported by the data if the asymptotic p-value based on a LR statistic is used. Note that this LR statistic uses Black version of the CAPM as the unconstrained model (the *alternative* hypothesis of the test). In this case, the p-values indicate that integration cannot be rejected in any sub-period the 5% level.

However, as discussed in part II, an alternative statistic LR_u is available to assess integration: LR_u differs from LR only regarding its *alternative* model which relaxes Black model; it is also *closer* to our proposed bound (i.e. it is, in principle, more powerful). When we use this test statistic, integration is strongly rejected. In fact, p-values for all sub-periods are less than 1%. In this case, our evidence contradicts Mittoo's results and the general belief that market integration is more prevalent over time.

As for the segmentation test, every statistic used, the asymptotic p-values and the bound p-values associated with LR and $LR_{u,}$ are significant at the 5% confidence level.

Hence, segmentation is rejected for every sub-period. Since we reject both pure integration and pure segmentation when using the appropriate test statistic, our evidence seems to suggest a mild integration/segmentation scenario, meaning that the North-American financial markets are neither fully integrated nor fully segmented. As for the important differences we find using the LR or LR_u statistics, we believe it casts doubts on the validity of Black's CAPM underlying our integration tests. In other words, our results suggests that the version of the CAPM selected in this analysis is not be compatible with the data in a test of integration of North American financial markets in the 1984-2003 period.

The APT model

Results are reported in Table II. We have tested jointly the equality of coefficients on equation (15) for Canada and the United States. The first panel of Table II reports results without the split sample methodology. In this case, integration is rejected in every sub-period. Panel 2 reports results with different sample splits. We must first acknowledge some convergence problems due to small samples in cases where the LR statistics is equal to –1 (i.e. –1 is our symbol for numerical problems). Moreover, integration is rejected for most of the sub-periods and over most of the split-samples considered. The only exceptions are: (i) the 1994-1998 sub-period with a split sample using the months of March, June, September and December of every year to pre-estimate the sensitivity and the remaining month to evaluate the risk premiums, and (ii) the 1989-1993 sub-period with a split sample using April, August and December of every year to pre-estimate the sensitivity and the remaining month to estimate risk premiums. In these two cases, integration cannot be rejected at a 5% confidence level. Thus, we can conclude that testing integration in North American financial markets using an APT framework coupled with a split sample methodology strongly rejects the integration hypothesis. Thus, we can conclude that Fama and French factors seem to have a different effect on stock returns in Canada and in United States.

Conclusion

In this paper, we have tested integration for North American financial markets from 1984 to 2003. We have used a theoretical framework similar to the one introduced by Mittoo (1992). First, financial markets integration was tested using a CAPM with a non linear constraint on the intercept. The method we develop in this paper to solve the "Dimensionality Curse" was to derive a pivot in order to bound the distribution of the test statistic under the null distribution. Results show that integration cannot be rejected when Black CAPM is used for the constrained alternative, but it is no longer supported by the data when the alternative does not impose Black's model. In fact, integration is rejected for every sub-period when the model is tested against an unconstrained model for the return generating process. This suggests that Black's model is rejected by the data. An improvement to our test would be to relax the normality hypothesis used to derive the pivotal cut-off point; Monte Carlo test methods could be used instead. Nevertheless, our F-based p-values are very small which suggests (see Beaulieu, Dufour and Khalaf (2004a,b)) that our rejections are not due to normal approximations.

We have also tested integration with a second model: the APT framework with pre specified factors. We have used Fama and French factors and portfolios to test the equality of coefficients of equation (15) for Canada and the United States from January 1984 to December 2003. Moreover, we have introduced a split sample methodology to correct for the pre estimation of the BETAS. We found that financial markets integration was rejected for every splitting cut off point we chose in our sample except for two sub periods. We therefore concluded that there was no direct correspondence between the size and book to market indicators in Canada and in the United-States. A possible improvement of this methodology would be to rearrange Fama and French portfolios to have a better match between Canada and the United States. In this respect, we find that the joint null hypothesis (as set up in Mittoo (1992)) is possibly that integration is too constraining for our Fama and French factor based model; testing the equality of the sum of coefficient between the two countries may be a more appropriate procedure. Finally, a test where the risk free rate is imposed (and not estimated) for the intercept would probably yield better results. In fact, many sub-periods had negative estimates (R_F) for the intercept. This is obviously questionable. In this context, testing the equality of the Fama and French factors' coefficient portfolio excess return as the independent variable might provide us with interesting insight with respect to North American financial markets integration.

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Tables

Table I- The CAPM Model Result for the Integration and Segmentation Hypothesis

The tests of Integration are done using the model in (5):

$$R_{it} - R_{Ft} = \gamma_0^I (1 - \beta_i^I) + \gamma_2^{D-I} \beta_i^{D-I} + \beta_i^I (R_{It} - R_{Ft}) + \beta_i^{D-I} V_{(D-I)t} + e_{it}^I$$

where R_{it} is the monthly return of the six Fama and French portfolios, R_{It} is the monthly return on the value weighed integrated market index at t, R_{Ft} the one month Canadian T bill Rate at time t, $V_{(D-I)t}$ is the residual at time t obtained by the projection of the Canadian market index on the integrated market index. Parameters of the equation are estimated jointly by maximum likelihood. Market integration implies that $\gamma_2^{D-I} = 0$. The statistics LR and LRu as well as their bound-based cut-off points are described in section II.

Results from the CAPM model for the integration and segmentation hypothesis

Test of Integration:

periods	γ_0^I	γ_2^{D-I}	LR	Asymptotic p-value of LR	LR_u	Bound p-value of LR	Bound p-value of LR_u
1984-2003	-0.499996	0.0095845	0.108192	0.999803	116.82350	0.999999	0.000201
1984-1988	-0.049970	0.0000001	2.381164	0.794276	24.144866	0.906205	0.001376
1989-1993	-0.049998	0.0000001	2.868582	0.720238	39.872557	0.859390	0.000003
1994-1998	-0.049999	0.0000124	2.667652	0.751061	56.378413	0.879545	0.000001
1999-2003	-0.049996	0.0014755	3.637786	0.602649	53.715096	0.774027	0.000001
1984-1993	-0.499997	0.0000542	2.266247	0.811211	46.099168	0.916128	0.002068
1994-2003	-0.499999	0.0001670	0.152709	0.999540	97.353710	0.999948	0.000001

Note: For presentation clarity, γ_2^{D-I} was multiplied by a factor e-06..

Table I- continued

Test of segmentation are done using equation (6):

$$R_{it} - R_{Ft} = \gamma_0^D(1-\beta_i^D) + \gamma_2^{I-D}\beta_i^{I-D} + \beta_i^D(R_{Dt} - R_{Ft}) + \beta_i^{I-D}V_{(I-D)t} + e_{it}^D$$

where R_{it} is the monthly return of the 25 Fama and French portfolios, R_{Dt} is the monthly return on the value weighed domestic market index at t, R_{Ft} the one month Canadian T bill Rate at time t, $V_{(I-D)t}$ is the residual at time t obtained by the projection of the integrated market index on Canadian market index. The parameters of the equation are estimated jointly by maximum likelihood. Market segmentation implies that γ_2^{I-D} = 0. The statistics LR and LRu as well as their bound-based cut-off points are described in section II.

Test of Segmentation:							
periods	γ_0^D	γ_2^{I-D}	**LR**	**Asymptotic p-value of LR**	LR_u	**Bound p- value of LR**	**Bound p- value of LR_u**
1984-2003	0.000227	0.004158	97.278379	0.000001	227.20630	0.000001	0.000001
1984-1988	-0.050000	-499.9991	48.122200	0.000001	59.877855	0.000001	0.000001
1989-1993	0.000091	0.001663	21.185378	0.000747	60.135034	0.004101	0.000001
1994-1998	0.000226	0.004158	33.881423	0.000001	93.754470	0.000033	0.000001
1999-2003	0.000226	0.004157	14.765565	0.011412	62.267135	0.038902	0.000001
1984-1993	0.000227	0.004157	62.484195	0.000001	106.75871	0.000092	0.000001
1994-2003	0.000226	0.004158	40.582331	0.000001	147.26927	0.005672	0.000001

Note: For presentation clarity, γ_2^{I-D} was multiplied by a factor e^04.

Table II- The Apt Model Results

The risk premiums are estimated using a seemingly unrelated equation model for 25 Canadian portfolios and 25 American portfolios from 1984 to 2003. The risk factors used are Fama and French factors. The sensibilities of Fama and French factors(β) of each portfolios are pre-estimated in cross-section. The risk premiums are evaluated with and without the split sample methodology. The test statistic used is the LR test and an asymptotic p-value. Results were obtained for empirical model in equation (13).

PANEL 1 The Risk Premia for the APT model without the split sample methodology,										
	Canadian risk premia				American risk premia				Test statistic	
Period	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{CDN}	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{US}	LR Statistic	Asymptotic P-Value
1984-2003	1.010	-3.491	2.505	5.152	0.997	-1.526	4.830	2,346	79.346	0.000001
1984-1988	1.577	-0.731	-1.737	-0.764	1.605	-0.422	0.631	-0,764	31.012	0.000003
1989-1993	1.278	-1.457	-2.794	-0.626	0.489	-0.108	0.131	0,795	-5.737	-1
1994-1998	2.784	-3.120	-4.038	-1.301	-0.167	-0.167	-0.651	1,818	300.378	0.000001
1999-2003	-0.733	-2.869	-3.320	1.783	-1.942	0.857	0.132	2,205	264.203	0.000001
1984-1993	2.509	-1.077	-2.321	-1.757	0.847	-0.276	0.372	0,407	101.563	0.000001
1994-2003	-0.546	-2.918	-3.615	1.774	-2.032	0.018	0.018	3.098	-111.013	-1

Note: –1 is our symbol for numerical problems, i.e. absence of convergence due to small samples. An asterisk indicates that the p-value, is smaller than the indicated value.

Table II- continued

PANEL 2

The Risk Premia for the APT Model with a split sample using the first 30% of datas used to pre-estimate the factor sensitivity and the remaining 70% to evaluate the Risk Premia

	Canadian risk premia				American risk premia				Test statistic	
Period	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{CDN}	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{US}	LR Statistic	Asymptotic P-Value
1984-2003	5.454	-2.196	-2.376	-5.032	-1.721	0.106	0.248	2.856	115.613	0.000001
1984-1988	1.462	-0.230	-0.880	-0.483	-0.148	-0.445	0.262	1.426	111.301	0.000001
1989-1993	1.654	-1.132	-1.151	-0.859	-0.526	0.101	0.506	1.781	-55.166	-1
1994-1998	0.956	-3.613	-2.888	-0.107	-0.244	-0.710	0.326	2.041	111.840	0.000001
1999-2003	0.294	-2.060	-2.126	-0.278	-0.199	0.778	2.399	0.010	-383.212	-1
1984-1993	3.340	-0.814	-2.775	-3.017	0.060	-0.234	0.265	1.177	80.233	0.000001
1994-2003	4.122	-2.585	-2.731	-4.041	-2.240	0.266	0.460	3.282	189.432	0.000001

The Risk Premia for the APT Model with a split sample using the first 40% of datas used to pre-estimate the factor sensitivity and the remaining 60% to evaluate the Risk Premia,

	Canadian risk premia				American risk premia				Test statistic	
Period	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{CDN}	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{US}	LR Statistic	Asymptotic P-Value
1984-2003	-1.343	-2.435	-3.665	1.855	-2.653	0.104	0.532	3.806	278.150	0.000001
1984-1988	1.449	-0.241	-1.070	-0.789	0.098	-0.474	0.432	1.053	61.545	0.000001
1989-1993	0.637	-0.977	-0.693	0.757	-0.672	0.560	0.475	2.408	95.462	0.000001
1994-1998	2.076	-3.770	-2.678	-1.222	2.574	-0.763	-0.798	0.272	113.421	0.000001
1999-2003	-0.161	-1.629	-1.977	0.356	-1.245	1.075	1.006	1.079	55.911	0.000001
1984-1993	3.978	-0.890	-2.454	-3.448	0.693	-0.063	0.337	0.623	-213.720	-1
1994-2003	2.140	-2.852	-3.537	-1.657	-2.911	0.350	0.512	3.660	234.096	0.000001

Note: –1 is our symbol for numerical problems, i.e. absence of convergence due to small samples.

Table II- Continued

The Risk Premia for the APT Model with a split sample using the month of March, June, September and December of every year to pre-estimate the sensitivity and the remaining mounth to evaluate the risk premia,										
	Canadian risk premia				American risk premia				Test statistic	
Period	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{CDN}	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{US}	LR Statistic	Asymptotic P-Value
1984-2003	2.854	-1.571	-2.866	-1.348	-0.220	-0.219	0.426	1.423	409.179	0.000001
1984-1988	0.682	0.030	-0.812	0.684	1.498	-0.458	0.329	0.240	-40.670	-1
1989-1993	0.431	0.004	-1.679	-1.186	0.010	-0.697	0.053	0.921	83.994	0.000001
1994-1998	2.983	-1.255	-4.578	-1.497	-1.170	0.104	0.634	2.394	7.045	0.134000
1999-2003	-0.221	-1.501	-2.768	2.023	-0.836	-0.292	0.272	2.077	91.158	0.000001
1984-1993	0.631	-0.318	-1.548	-0.268	0.731	-0.518	0.245	0.583	103.316	0.000001
1994-2003	0.770	-1.495	-3.323	0.936	-0.646	-0.024	0.435	1.809	-193.756	-1
The Risk Premia for the APT Model with a split sample using the month of April, August and December of every year to pre-estimate the sensitivity and the remaining month to evaluate the risk premia,										
	Canadian risk premia				American risk premia				Test statistic	
Period	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{CDN}	λ_{smb}	λ_{hml}	λ_{rm}	R_F^{US}	LR Statistic	Asymptotic P-Value
1984-2003	0.633	-1.619	-2.440	0.368	-0.671	-0.413	0.387	2.032	869.076	0.000001
1984-1988	0.915	-0.233	-1.006	0.280	0.035	-0.562	0.354	1.852	153.222	0.000001
1989-1993	-1.237	-0.967	-1.991	1.043	0.355	-0.383	-0.184	0.475	4.875	0.300000
1994-1998	0.080	-0.845	-1.814	0.467	-0.371	0.018	0.641	1.200	-216.908	-1
1999-2003	1.510	-3.317	-3.631	0.576	-1.566	-0.707	-0.220	3.634	262.951	0.000001
1984-1993	0.339	-0.779	-1.393	0.176	0.201	-0.489	0.095	1.142	257.446	0.000001
1994-2003	0.391	-1.930	-2.954	0.818	-1.207	-0.348	0.335	2.621	368.493	0.000001

Note: –1 is our symbol for numerical problems, i.e. absence of convergence due to small samples.