

The Cyclical Behaviour of the Small-Cap Premium: A Regime-Switching Approach

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Abstract: While the average annual small-cap premia for the US and Canada are substantial over long horizons, there is considerable time variation of this premium within and across these countries. For the US, during expansions, the average annualized premium is a sizable 5.44%, while during recessions, there is a small-cap discount of 6.23%. The differentials are less pronounced in Canada. This paper investigates the hypothesis that the variation of the small-cap premium is related to macroeconomic and financial variables that can be captured by a nonlinear time series econometric model, i.e., the smooth transition autoregressive model (STAR model), with different factor sets across regimes between and countries. The regimes reflect expansionary vs. contractionary phases of the business cycle. For the Canadian small-cap premium, an augmented factor model that includes US factors dominates a purely domestic factor model, which is consistent with integrated markets.

Keywords: small-cap premium; business cycles; nonlinear modelling

JEL Classification: G10; G11; G14

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1. Introduction

The small-firm effect refers to the empirical observation that small-capitalisation stocks tend to outperform on average larger capitalisation stocks over the long run and that this outperformance cannot be attributed solely to differences in market risk (e.g., [Banz, 1981](#); [Reinganum, 1981](#); [Hawawini and Keim, 1999](#)). Several papers have challenged this result (e.g., [Brown et al., 1983](#); [Bhardwaj and Brooks, 1993](#); [Dimson and Marsh, 1999](#); [Horowitz et al.,](#)

2000; Schwert, 2003). More recently, Van Dijk (2011) noted that while the small-cap premium disappeared through the latter two decades of the twentieth century, it has made a strong resurgence since the beginning of the millennium: Indeed, US small-caps returns earned a premium over large caps of 6% per year over the period 2000–2014.

This paper provides a new approach to assessing the time-varying nature of the small-cap premium for Canada and the US, by testing the hypothesis that the link between macroeconomic and financial variables that drives this premium (or discount) is dependent on the business cycle. The hypothesis is motivated by the empirical regularity that small-cap firms outperform (underperform) large-cap firms during periods of economic expansion (contraction). Only a few studies have looked at this issue to date (e.g., Chan et al., 1985; Switzer, 2010, 2013). Figure 1 provides a graphical illustration of this phenomenon for the US experience since 1926. Comparable data are available for Canada since 1970 and are projected on Figure 2. In both cases, a downward trend in the small-cap premium can be seen at the onset of recessionary periods, including the most recent short Canadian recession, which lasted from November 2008 to May 2009, and the US Great Recession from May 2007 to June 2009, denoted as the shaded areas within the graphs.



Figure 1 US small-cap premium. January 1926 (=100)–December 2013. Shaded areas indicate recessionary periods.

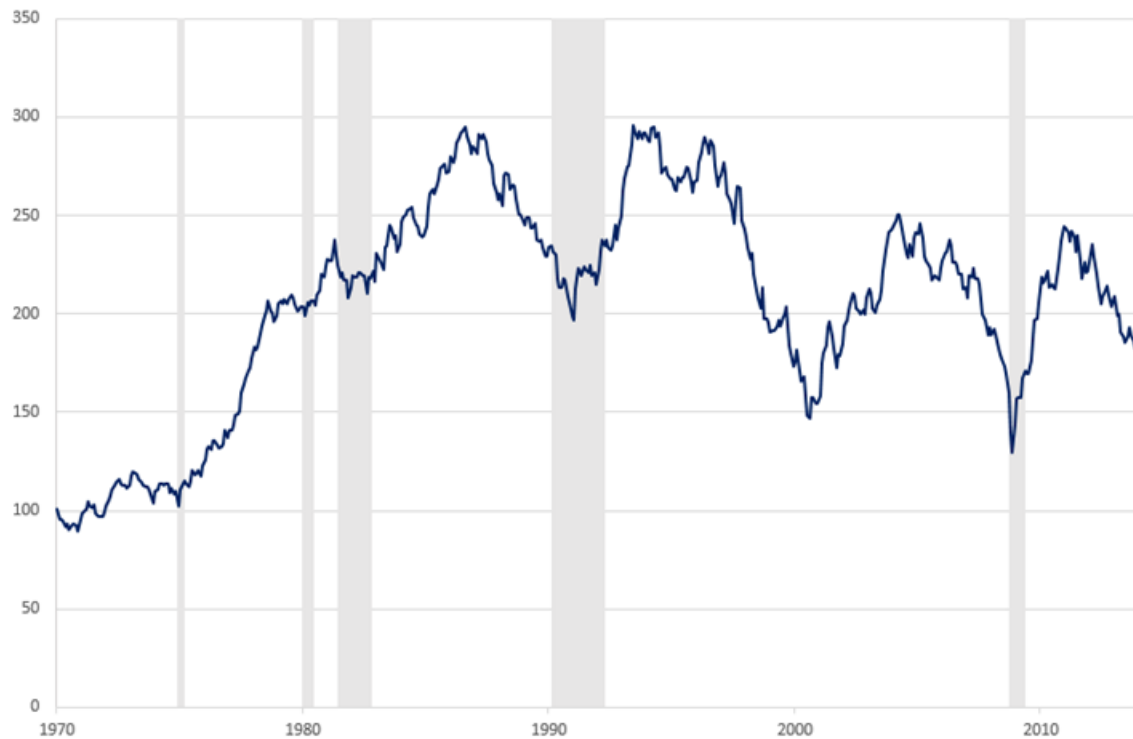


Figure 2 Canadian small-cap premium. January 1970 (=100)–December 2013. Shaded areas indicate recessionary periods.

Over the period 1926–2014 for the US, during expansions, the average annualized premium is a sizable 5.44%, while during recessions, there is a small-cap discount of 6.23%. Small-cap stocks may be more exposed to systematic default risk related to the business cycle. This study employs the smooth transition autoregressive model (STAR model) as the approach for estimating the conditional asset pricing dynamic and, hence, to explore the relationship between the small-firm premium and financial and macroeconomic variables in the Canadian and US economies.

Two of the most important asset pricing models in modern finance theory are the capital asset pricing model (CAPM) proposed by [Sharpe \(1964\)](#) and [Lintner \(1965\)](#) and the arbitrage pricing theory (APT) suggested by [Ross \(1976\)](#). Both specifications assert that the expected return of an asset is a linear function of risk; in CAPM, risk is measured by the covariance of the asset return with the return to the market portfolio, and in APT, risk is estimated as exposure (covariance) to a set of factors, which may comprise the market portfolio, amid others. Although the CAPM and the APT specifications suggest that the relationship between return and risk is linear, there is increasing empirical evidence suggesting that applications of these factor models should control for time-varying risk factor premiums and risk factor exposures or betas, and that doing so provides some improvement. For instance, [Blume \(1971\)](#), [Levy \(1971\)](#), [Fabozzi and Francis \(1978\)](#), [Chen \(1981\)](#), [Ferson and Harvey \(1991, 1999\)](#) and [Ferson and Korajczyk \(1995\)](#) showed that estimated beta coefficients depend on whether the capital markets are under high or low volatility regimes, in linear versions of the CAPM. These empirical observations could explain the reason the predictable power of several factors employed in the literature to predict excess aggregate equity returns, like dividend yields, term spreads and default spreads, decreased or even disappeared over the nineties, as documented by [Goyal and Welch \(2008\)](#) and [Ang and Bekaert \(2007\)](#).

Time-varying betas and factor loadings can be justified by the reasonable supposition that the relative risk and the expected excess returns of securities are related to their sensitivity to changes in the state of the economy. In other words, the estimated beta coefficients under a low volatility regime differ significantly from their counterparts under a high volatility regime. Several studies showed superior performance of dynamic conditional versions of the CAPM and APT asset pricing models in explaining and predicting stock returns relative to their static and unconditional forms (counterparts) (see, e.g., [Bansal and Viswanathan, 1993](#); [Jagannathan and Wang, 1996](#)). [Ammann and](#)

Verhofen (2008) documented that time variation of betas in the CAPM and the time variation of the coefficients for the size factor (SMB) and the distress factor (HML) in the three-factor model enhance the empirical performance in describing the cross-section of returns of the S&P500 constituents.¹ Goyal and Welch (2008) and Henkel et al. (2011) showed that the predictability of conditional models appears stronger during periods of economic contractions, as opposed to periods of expansion.

This article extends the Goyal and Welch (2008) and Henkel et al. (2011) papers which examine the performance of variables that have been suggested by the academic literature to be good predictors of the equity premiums, by investigating *the size premium* rather than instead of the aggregate market risk premium. Moreover, this paper applies a different approach to those of Perez-Quiros and Timmermann (2000), who modelled excess returns of size-sorted decile portfolios by investigating the small-cap premium measured as the difference between returns of the 33% smallest firms and 33% largest firms. We found that the significances of some risk exposures coefficients (i.e., inflation and term risk factors) appear negligible during business cycle expansions but nontrivial during contractions.

As mentioned previously, the model estimated is the smooth transition autoregressive (STAR) econometric model, which shows that the small-cap premium is related to some macroeconomic and financial variables among the default, term, inflation, short-term rate and dividend yield factors, and that relationship is driven by the economic cycle in the United States as well as Canada.

The organization of the paper is as follows. Section 2 reviews the literature that examines the cyclical nature of the small-cap premium. Section 3 discusses the modelling approach. Section 4 provides a description of the data. The empirical results follow in Section 5. The paper concludes with a brief summary in Section 6.

2. The Cyclical Nature of the Small-Cap Premium: Literature Review

Several studies have examined the time-varying nature of the small-cap premium. Some of these studies link the premium to conventional macroeconomic risk factors, using an efficient markets perspective. Others adopt a behavioural approach. Both approaches, which are presented below, converge in the nature of their predictions: that the premium should reflect the state of the economy over the business cycle.

One of the most well-known explanations of the small-firm premium is that firm size is a proxy for some undiversifiable and undisclosed macroeconomic or other specific risk factor(s) that influence(s) the dynamic of expected asset returns. If so, the observed small-firm premium reflects investors' compensation for the exposure to risk. This risk-based approach is even more discernible and apparent, according to numerous studies mentioned below, by the fact that during expansionary periods, small firms usually grow faster than large, mature firms. In contractionary periods, on the other hand, small firms are more exposed to bankruptcy risk and perform relatively poorly. To reduce exposure to such risks, investors are more prone to exit such stocks in search of safer investments.

¹Earlier studies that document better performance of the conditional models over unconditional models include Harvey (1989), Ferson and Korajczyk (1995) and Carhart (1997). These papers show that the time variation (changes) in betas (risk exposures) contributes modestly to the time variation in expected asset returns, while time variation in the risk premium is relatively more significant. However, while time variation in conditional betas is not as critical as time variation in expected risk premiums, from the standpoint of modelling the dynamics of securities returns, this does not imply that beta variation is empirically unimportant: beta variation over time remains empirically crucial.

Fama and French (1992, 1993, 1996, 2015) are the leading proponents of this risk-based approach.² In their most recent study (Fama and French, 2015), they introduced a five-factor model that includes size (SMB), value, profitability and investment patterns to explain average stock returns. While their model has been shown to perform better than the three-factor model of Fama and French (1993), it is unable to capture the returns of small-cap stocks, whose returns are similar to those of firms with considerable investment activity, despite low levels of profitability. Their study does not develop a comprehensive theory for what the underlying systematic risk factors in their model represent. Nor do they look specifically at business cycle effects, however. It may be the case that the outperformance of small firms during expansionary periods may be due to their reaping the rewards from staying the course on their investments during recessions.

Perez-Quiros and Timmermann (2000), in a paper closely related to ours, used a Markov switching model with Center for Research in Securities Prices (CRSP) data over the sample period January 1954–December 1997. They modelled excess returns on each of the size-sorted decile portfolios as a function of an intercept term and lagged values of the one-month T-bill rate, a default premium, changes in the money stock and the dividend yield. They demonstrated that small firms display the highest degree of asymmetry in their conditional return distribution across recession and expansion states. In a recession, small firms' risk is most strongly affected during recessions by worsening credit market conditions as reflected in higher default premia and higher interest rates. They did not account for the possible differential effects of inflation or the term structure of interest rates, however. Our paper revisits this question using more recent data and a more flexible modelling approach than Perez-Quiros and Timmermann (2000), i.e., the smooth transition autoregressive model (STAR).

Liew and Vassalou (2000) investigated whether the dynamics of the Fama–French factors, as well as the Carhart (1997) momentum factor, can be attributed to the future GDP growth across ten countries. Analyzing ten countries between 1978 and 1996, they showed that the SMB factor carries significant information about future GDP growth that is not related to the information included in the market factor. Zhang et al. (2009) also discovered a positive link between the SMB factor and future GDP growth and a negative relationship between SMB and unexpected

²Several studies look at the impact of economic factors on the small-firm effect, but not within the Fama–French risk factor framework. Reinganum (1982) investigated the differential return between small and large stocks between 1926 and 1989 to assess the economic cyclical dynamic and observed that the small-capitalization stocks outperformed the large firm stocks, but this return behaviour was volatile and tended to reverse itself. In a similar vein, Chan et al. (1985) reported that the firm size effect vanishes when the traditional capital asset pricing model framework is augmented to include several economic factors, such as the change in expected inflation, unanticipated inflation, default risk premium and a term structure variable. They concluded that the variations in the default risk premium are positively related to changing economic conditions. Chan and Chen (1991) tested for factors that can explain the variability of the small-firm effect across the business cycle. In particular, during periods of economic expansion, small firms generate large abnormal profits; however, in periods of economic downturn, no abnormal small-firm stock returns performance is manifest. They showed that most small firms are characterized by relatively low production efficiency, lower return on assets, high financial leverage and high sensitivity of cash flows to adverse economic developments, consequently making them more vulnerable to adverse changes in business conditions and economic downturns. They found that their small-firm portfolio contains a large proportion of marginal firms—firms with low production efficiency and high financial leverage. In addition, they showed that indices that reflect production efficiency and financial leverage are as powerful as log(size) in explaining average returns of size-ranked portfolios. Kim and Burnie (2002) asserted that differentially higher returns for small-cap firms relative to large firms are observed during economic expansion phases and investigated whether that time-varying nature of the firm size effect may be attributable to the state of the business cycle or due to uncertainty factors including default risk, interest rate risk and inflation risk that may be distinct from economic cycle effects for small-cap vs. large-cap firms. They found evidence that the differential returns for small firms vs. large firms are due to the business cycle, as captured by dummy variables in their regression model. Moscarini and Postel-Vinay (2010) asserted that the small-firm effect is linked to job creation: Large companies lay off proportionally more employees during and following recessions and hire proportionally more employees late in expansions than do small firms. In their subsequent paper, Moscarini and Postel-Vinay (2012) showed that this dissimilar employment pattern is able to explain in part the larger performance of small US firms during periods of economic growth. Vassalou and Xing (2004) analyzed US stock return data from 1971 to 1999 and found that the small-firm effect is statistically significant only for the quintile of stocks with the greatest default risk. These results suggest that the size effect reflects default risk and that market capitalization may reflect default-related information. Switzer (2010) investigated the return dynamic of small caps and large caps during periods of economic downturns and expansions and reviewed the relationship between the small-firm effect and the business cycle in Canada and the United States. This study shows that small-cap firms outperform large caps over the year following an economic trough but underperform in the year preceding an economic peak and that the US small-cap premium is associated with default risk.

inflation. Small-cap stocks were also found to generate greater returns than large-cap stocks when the short-term rates are low, and the term spread is high. [Petkova \(2006\)](#) asserted that the SMB portfolios may be linked to shocks in state variables that forecast excess market returns. A model that relates average stock returns to variations in aggregate dividend yield, default spread and short-term Treasury-bill rates was shown to outperform the [Fama and French \(1995\)](#) three factor model in explaining the cross-sectional variation in equity returns. When loadings on the shocks in the predictive variables were incorporated in the model, the loading on the SMB factor lost its explanatory power, implying a strong correlation between the SMB portfolio and the default spread.

Other researchers have tried to explain the small-firm effect by including time variation in the covariance of asset returns with the market return (conditional CAPM) or with consumption growth (conditional consumption CAPM). In these models, the asset's beta is not constant as in the traditional CAPM but fluctuates to reflect variations in a predefined conditioning variable. The economic reasoning behind a conditional model for the small-firm effect is that small- and large-cap stocks may have different sensitivities to systematic risk in good and bad times. [Lettau and Ludvigson \(2001\)](#) used the log-consumption-to-wealth ratio as a conditioning variable to demonstrate that conditional specifications perform superiorly to unconditional models and comparably to the Fama-French three-factor model in describing the cross-section of average returns. Once the conditioning information conveyed by the log-consumption-to-wealth ratio is incorporated in the specification, no residual small-firm effect persists in the data.

Likewise, [Santos and Veronesi \(2006\)](#) demonstrated that using the fraction of total income produced by wages as a conditioning variable in the CAPM describes the cross-section of 25 Fama-French portfolios formed on value and size. Small-firm stocks display evidence to be riskier in bad times, exhibiting higher betas in market downturns.

[Campbell and Vuolteenaho \(2004\)](#) presented strong empirical evidence that the outperformance of small stocks is caused by higher cash flow risk. The authors rationalised the small-firm effect via an economically induced two-beta model in which they split the CAPM beta of a stock into two elements: one that reflects news about the company's future cash flows and one that reflects news about the discount rate. Intertemporal asset pricing theory suggests that risk-averse investors avoid cash flow risk (the "bad beta") more than discount rate risk (the "good beta"). Consequently, the price of cash flow risk is greater than the price of the "good" discount rate risk. In equilibrium, the ratio of the two prices must equal the risk aversion coefficient that makes an investor satisfied to hold the aggregate market. They subsequently showed empirically that small stocks have significantly greater cash flow betas than large stocks, which can explain their higher average returns in the cross-section. The two-beta model hence implies that investors with higher tolerance for risk and a long-term investment horizon will massively invest in these stocks compared to the average investor.

In contrast to (systematic) risk factor explanations within the efficient markets framework of the small-firm premium, other studies have linked the premium to behavioural factors. [Chan and Chen \(1991\)](#) indicated that small firms tend to be firms that have done poorly in the past. The small-firm effect would then be consistent with the overreaction hypothesis of [De Bondt and Thaler \(1985\)](#). Based on [Daniel and Titman \(1997\)](#) and [Lakonishok et al. \(1992\)](#) claimed the small-firm effect may be due to investor preferences for large firms over small firms. This preference might be amplified during economic downturns as investors seek investments with less perceived risk.

More recently, [Lemmon and Portniaguina \(2006\)](#) provided evidence of a negative link between investor sentiment and the dynamic behaviour of returns on small-firm stocks since 1977. They argued that investors are inclined to overvalue small-cap stocks versus large-cap stocks when they are particularly bullish and undervalue them when they are bearish. Sentiment has a particularly great impact on small-cap stock valuations because small firms are usually held by individual traders who are more likely to be influenced by sentiment. However, they uncovered no link between investor sentiment and small-cap returns before 1977 and provided no explanation on the decrease of the small-firm effect after 1981.

In sum, both the efficient markets explanations as well as the behavioural-based approaches suggest that a regime dependent model is appropriate for examining the time-varying nature of the small-cap premium. Furthermore,

these approaches imply that the factors affecting the premium are sensitive to the state of the economy. This paper is the first to provide a direct test of these assertions, using recent advances in nonlinear time series modelling for the small-cap premium in the US and Canada.

3. The Smooth Transition Autoregressive (STAR) Model

This section provides a review of the nonlinear econometric model that is employed to investigate the relationship between the small-cap premium and several macroeconomic and financial variables. The STAR model, which was developed by Teräsvirta (1994) and Granger and Teräsvirta (1993), has been extensively used in the past two decades to model nonlinearities in the dynamic properties of many economic time series and summarize and explain the cyclical behaviour of macroeconomic data and business cycle asymmetries.

The smooth transition autoregressive (STAR) model for a univariate time series y_t is given by:

$$y_t = \alpha_0 + \sum_{i=1}^p \alpha_i y_{t-i} + F(\xi_t, \gamma, c) \left[\beta_0 + \sum_{i=1}^p \beta_i y_{t-i} \right] + \varepsilon_t, \tag{1}$$

where $F(\xi_t, \gamma, c)$ is a transition function which controls for the switch from one regime to the other and is bounded between 0 and 1. The scale parameter $\gamma > 0$ is the slope coefficient that determines the smoothness of the transition: The higher it is, the more abrupt the change from one extreme regime to the other ξ_t . The location or threshold parameter between the two regimes is represented by c , and ξ_t is called the transition (threshold) variable, with $\xi_t = y_{t-d}$ (d a delay parameter).

Two standard selections for the transition function are the logistic function (LSTAR) and the exponential function (ESTAR). The LSTAR function is specified as:

$$F = [1 + \exp(-\gamma(\xi_t - c))]^{-1}, \tag{2}$$

while the ESTAR function is specified as:

$$F = 1 - \exp(-\gamma(\xi_t - c)^2). \tag{3}$$

The main difference between these two STAR models relies on how they describe macroeconomic series dynamic behaviour. The LSTAR model reflects the asymmetrical adjustment process that usually characterizes economic cycles: a sharper transition and sharp recovery following business cycle troughs compared to economic peaks. By contrast, the ESTAR specification suggests a symmetrical adjustment dynamic.

To determine the adequate transition function to apply to the data, Teräsvirta (1994) suggested a model selection procedure which is explained and applied in Section 4.

While an exogenous variable could be employed as the transition variable, in this paper, as per the majority of research studies using STAR models, the dependent variable (the macroeconomic proxies) plays this role and d equals one, meaning that the first lagged value of the macroeconomic variable investigated acts at the threshold variable.

In smooth transition autoregression (STAR), all predetermined variables are lags of the dependent variable. An extension to the STAR model is to amend the STAR model to allow for exogenous variables x_{1t}, \dots, x_{kt} as additional regressors. In this study, the applied STAR model includes other exogenous factors, i.e., default, term structure, inflation, short-term interest rate and the dividend yield risk factors. The standard method of estimation of STAR models is nonlinear least squares (NLS), which is equivalent to the quasi-maximum likelihood approach.

Two interpretations of a STAR model are possible. First, the STAR model may be thought of as a regime-switching model that allows for two regimes, associated with the extreme values of the transition function, $F(\xi_t; y, c) = 0$ and $F(\xi_t; y, c) = 1$, where the transition from one regime to the other is smooth. The regime that occurs at time t is determined by the observable variable ξ . Second, the STAR model can be said to enable a continuum of states between the two extremes. The key advantage in favour of STAR models is that changes

in some economic and financial aggregates are influenced by changes in the behaviour of many diverse agents, and it is highly improbable that all agents respond instantaneously to a given economic signal. For instance, in financial markets, with a considerable number of investors, each switching at different times (probably caused by heterogeneous objectives), a smooth transition or a continuum of states between the extremes seems more realistic.

Macroeconomic variables and premiums related to size, value and liquidity are frequently subject to switching regimes, and this notion of the regime switch implies a sudden abrupt change. Yet, most macroeconomic fundamentals and premiums change regimes in a smooth manner, with transition from one regime to another taking some time.

To reflect this particular characteristic, smooth transition autoregressive (STAR) models have recently been developed and seem to be more appropriate in modelling macroeconomic variables, since smooth transitions between regimes are often more convenient and realistic than abrupt switches.

In contrast to discrete switching models (e.g., Hansen, 1999), for instance, the Markov switching-regime model of Hamilton (1989), smooth transition regression (STAR) models transition as a continuous process dependent on the transition variable which allows for incorporating regime-switching behaviour both when the exact time of the regime change is not known with certainty and when there is a short or long transition period to a new regime which will be reflected by the estimate of the smoothness parameter, which will allow suggesting a very sharp or smooth switch from one regime to the other. Smooth transition models provide additional information on the dynamics of variables and are able to capture regime-switching behaviour in a flexible way and facilitate its economic interpretation (see Van Dijk et al. (2002) for a discussion of the benefits of this class of models). For instance, Sarno et al. (2003) argued that several theoretical models of money demand imply a nonlinear functional form of the aggregate demand for money, characterized by smooth adjustment towards a long run equilibrium.

Hence, this study extends Perez-Quiros and Timmermann's (2000) paper in three ways: (a) in the methodology to estimate the value of the small-firm premium; (b) by using an extended set of explanations (macroeconomic and financial); and (c) in its approach to approximate economic cycles. Perez-Quiros and Timmermann (2000) used the Markov switching regime to model the small-cap premium, while this paper applies the smooth transition autoregressive (STAR) model to describe its time series dynamic.

4. Data Description

This paper investigates the impact of several risk factors that have been assumed to be significant exposures influencing the returns to firms (Chen et al., 1986; Ferson and Harvey, 1991) and that may be independent from the state of the business cycle per se in affecting the return spread between large-cap and small-cap companies. These variables are the default, term, dividend, short-term rate and inflation risk factors. Their description is presented in more details in Appendix A.

Data Sources

Both the data on the US (DFA Small Cap Premium since January 1926) and Canadian (BMO Nesbitt Burns Small Cap Index)³ since January 1970) small-cap returns or premia were retrieved from the Ibbotson Associates (IA) database, whose methodology to define small stocks consists of sorting companies by market capitalization, i.e., stock price multiplied by shares outstanding and then splitting the group into deciles. Small-cap stocks comprise the

³Various small-cap indices for Canada are available for consideration. The longest series is the well known BMO–Nesbitt Burns unweighted small-cap price index which begins in January 1970. BMO/Nesbitt Burns also computes a weighted small-cap blended total return series that begins in January 1978. Morningstar Canada produces a Canadian Small–Mid-Cap series that begins in January 1978. The Russell Canada small-cap series begins in July 1996. Finally, the S&P TSX Small Cap Index was inaugurated in June 2002. Without exception, all of the small-cap proxies for Canada are highly correlated, with an average cross-correlation that exceeds 95%. To maximize the sample size for the analyses, we used the BMO/Nesbitt Burns unweighted index in the analyses. Since its inception, this index has a correlation with the US Small Cap Index of about 76%.

bottom quintile of capitalization (deciles 9–10), and the small stock premium measures the excess return of small over large stocks (first decile) over a period.

The five US risk factors were obtained from Morningstar. Default risk (bond default premium) is measured by the geometric difference between total returns on long-term corporate bonds and long-term government bonds. Term structure risk (bond horizon premium) is measured by the geometric difference between government long bond and Treasury bill returns. Inflation is based on the US consumer price index. The short-term rate is represented by the 1-month T-bill rate, and the dividend yield risk factor corresponds to the dividend yield on the S&P 500 index.

For Canada, interest rates, real return bonds and inflation rates were obtained from Statistics Canada’s CANSIM database. The Canadian dividend yield is measured relative to the S&P/TSX. The default risk premium variable is the difference between the yield on long-term Canadian corporate bonds and the government bond yield (CANSIM: series V122487) and is estimated following [Champagne et al. \(2015\)](#)’s methodology by combining three different series. For the period February 1950 to October 1977, the Scotia–McLeod Canada Long-Term All-Corporate Yield Index (CANSIM series V35752) was used followed by (from November 1977 to June 2007) the Scotia Capital Canada All-Corporations Long-Term bond yield (CANSIM series V122518). Finally, from July 2007 and onward up to December 2013, the yield from the Merrill Lynch Canada Long-Term Corporate Bond Index (F9C0) from Bloomberg was merged to the two previous series. The Canadian term structure variable is measured as the difference between the yield on long term Canadian government bonds and the Canadian three-month T-bill rate.

To further explore the link between the small-cap premium and different risk factors in a nonlinear form, this paper used the [Teräsvirta \(1994\)](#) Lagrange multiplier test for linearity versus an alternative of LSTAR or ESTAR in a univariate autoregression:

$$y_t = \beta_0 + \sum_{j=1}^p \beta_{1j} y_{t-j} + \sum_{j=1}^p \beta_{2j} y_{t-j} y_{t-d} + \sum_{j=1}^p \beta_{3j} y_{t-j} y_{t-d}^2 + \sum_{j=1}^p \beta_{4j} y_{t-j} y_{t-d}^3 + e_t. \tag{4}$$

In this study, both the lags value p and the delay parameter d equal 1.⁴ The null hypothesis of linearity is therefore $\beta_2 = \beta_3 = \beta_4 = 0$. If the null hypothesis is rejected, the next step is to choose between the LSTAR and ESTAR models by a sequence of nested tests:

- H₀₁ is a test of the first order interaction terms only: $\beta_2 = 0$
- H₀₂ is a test of the second order interaction terms only: $\beta_3 = 0$
- H₀₃ is a test of the third order interaction terms only: $\beta_4 = 0$
- H₁₂ is a test of the first and second order interactions terms only: $\beta_2 = \beta_3 = 0$

The decision rules of choosing between LSTAR and ESTAR models were suggested by [Teräsvirta \(1994\)](#): Either an LSTAR or ESTAR will cause rejection of linearity. If the null of linearity is rejected, H₁₂ and H₀₃ become the appropriate statistic if ESTAR is the main hypothesis of interest: If both H₁₂ is rejected and H₀₃ is accepted, this may be interpreted as a favour of the ESTAR model, as opposed to an LSTAR.

Table 1 exhibits the results of the [Teräsvirta \(1994\)](#) linearity test performed on US and Canadian small-cap premium and shows that the hypothesis of linearity is rejected for both countries, which implies that both small-cap premiums follow nonlinear dynamics. Furthermore, the table indicates that the hypothesis H₁₂ rejection and hypothesis H₀₃ acceptance do not occur simultaneously, which implies that a nonlinear model is the appropriate specification for both the US and Canadian small-cap premiums.

⁴There exists no econometric specification that allows precisely determining the value of the delay parameter p . Most of the literature related to nonlinear STAR models uses $p = 1$.

	US small-cap premium	Canadian small-cap premium
	F-Value Significance	F-Value Significance
Linearity	5.675 0.0007	6.226 0.0004
H_{01}	14.478 0.0001	0.197 0.6571
H_{02}	2.324 0.1277	1.057 0.3042
H_{03}	0.190 0.6625	17.450 0.0000
H_{12}	1.257 0.2848	9.255 0.0001

This table shows the results of Teräsvirta (1994)'s approach to first test for linearity of the small-cap premiums in the US and Canada. If the hypothesis of linearity is rejected and H_{03} is accepted while H_{12} is rejected, then the specification will point toward an exponential function, smooth transition autoregressive (ESTAR) instead of a logistic function (LSTAR) model.

Table 1 Teräsvirta (1994) Nonlinearity test results.

5. Empirical Results

Table 2 shows the descriptive statistics of the small-cap premium in the US and in Canada, and the five exposure risk variables i.e., default, inflation, term, dividend yield and the short-term rate (T-bill). On the whole, the small-cap premium is quite high in both the US and Canada. For the US, over the entire sample period, the average premium amounts to 0.0027 per month, or 3.24% per year. The annualized holding period excess return to small caps over large caps is about 2.1% over this period. For the subperiod January 1970–December 2013, the annualized average premium and annualized holding period premium to small caps over large caps increases to 3.60% per year and 2.55% percent, respectively. For Canada, the small-cap premium for the 1970–2013 period is lower than for the US: The annualized average premium is 1.82% a year, while the annualized holding period premium for small caps to large caps amounts to 1.38%. For these comparable periods, 1970–2013, the average Canadian and US risk default premium are higher similar (1.17% vs. 0.39% annualized). The term premium in Canada is also higher (0.0011 vs. 0.0034 monthly, 1.42% vs. 4.15% annualized), as is the inflation differential (0.0034 vs. 0.0030 monthly, 4.15% vs. 3.63% annualized). Finally, the Canadian short-term rate exceeds the US rate (0.0052 vs. 0.0042 monthly, 6.24% vs. 5.04% annualized), while the Canadian and US dividend yield present similar numbers (0.0024 monthly, 2.88% annualized).

Panel A		US			
Variable	Number Obs.	Mean	Std. Dev.	Min.	Max.
<i>Small-Cap Prem.</i>	1056	0.0027	0.046	-0.179	0.398
<i>Default</i>	1056	0.0004	0.013	-0.096	0.075
<i>Inflation</i>	1056	0.0024	0.005	-0.020	0.059
<i>Term</i>	1056	0.0019	0.023	-0.112	0.144
<i>T-Bill</i>	1056	0.0028	0.002	0.000	0.013
<i>Div. Yield</i>	1056	0.0031	0.002	0.000	0.016
Panel B		US			
Variable	Number Obs.	Mean	Std. Dev.	Min.	Max.
<i>Small-Cap Prem.</i>	528	0.0028	0.040	-0.168	0.259
<i>Default</i>	528	0.0003	0.014	-0.096	0.075
<i>Inflation</i>	528	0.0030	0.031	-0.112	0.143
<i>Term</i>	528	0.0034	0.003	0.018	-0.019
<i>T-Bill</i>	528	0.0042	0.002	0.000	0.013
<i>Div. Yield</i>	528	0.0024	0.001	0.000	0.009
Canada					
Variable	Number Obs.	Mean	Std. Dev.	Min.	Max.
<i>Small-Cap Prem.</i>	528	0.0075	0.054	-0.278	0.251
<i>Default</i>	528	0.0011	0.005	0.001	0.003
<i>Inflation</i>	528	0.0035	0.004	-0.010	0.026
<i>Term</i>	528	0.1000	0.017	-0.054	0.039
<i>T-Bill</i>	528	0.0052	0.003	0.000	0.017
<i>Div. Yield</i>	528	0.0024	0.000	0.000	0.005

Descriptive statistics for the US and Canada for the small-cap premium, the default factor, the inflation factor, the term risk factor, the dividend yield and the short-term rate (30 days). Panel A provides the estimates for the US over the period January 1926 through December 2013; panel B shows the results for both the US and Canada over the period January 1970–December 2013.

Table 2 Descriptive statistics. Panel A: January 1926–December 2013, Panel B: January 1970–December 2013.

5.1. Empirical Results for the US Small-Cap Premium

The empirical results for the US small-cap premium are reported in Table 3. Panel A shows the results for the complete sample period, January 1926–December 2013. Panel B shows the estimates for the most recent period (corresponding to the limit of the Canadian sample) for January 1970–December 2013. As shown, the regime-switching model identifies two distinct regimes for the small-cap premium: Regime 1, corresponding to a prosperity economic phase, and Regime 2, representing a contraction economic phase. In Panel A, the coefficients on the default risk factor are both strongly significant under both economic regimes. These results present evidence that default risk affects, for the longer sample period 1926–2013, the return differential between large-cap and small-cap firms and that this relationship is independent from the economic activity phases: The default risk coefficients remain extremely statistically significant under both regimes. Panel A of Table 3 also shows that the dividend yield exposure (coefficient of -1.522) is related to the US small-cap premium under high economic growth, while the inflation risk and term structure exposure coefficients (2.405 and 0.878, respectively) are positive and significant under recessions (Regime 2) but not under expansion phases (Regime I), indicating that term risk and inflation risk affect differentially small-cap vs. large-cap firm returns under contraction economic phases comparatively to economic prosperity.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Panel A				
Regime 1: Economic Expansion				
a_1	0.008	0.003	2.553	0.010
<i>Default</i>	0.307	0.122	2.522	0.011
<i>Inflation</i>	-0.013	0.289	-0.045	0.963
<i>Term</i>	-0.002	0.067	-0.031	0.974
<i>T-Bill</i>	-0.540	0.595	-0.908	0.363
<i>Div. Yield</i>	-1.522	0.666	-2.282	0.002
Regime 2: Economic Recession				
a_2	0.013	0.015	0.824	0.409
<i>Default</i>	2.484	0.547	4.537	0.000
<i>Inflation</i>	2.405	1.009	2.383	0.017
<i>Term</i>	0.878	0.408	2.148	0.031
<i>T-Bill</i>	-1.202	2.588	-0.464	0.642
<i>Div. Yield</i>	-2.950	3.452	-0.854	0.392
Panel B				
Regime 1: Economic Expansion				
a_1	-0.002	0.007	-0.400	0.689
<i>Default</i>	0.591	0.208	2.841	0.004
<i>Inflation</i>	0.024	0.100	0.238	0.811
<i>Term</i>	0.097	0.110	0.878	0.380
<i>T-Bill</i>	0.421	1.429	0.295	0.768
<i>Div. Yield</i>	-1.613	2.423	-0.665	0.505
Regime 2: Economic Recession				
a_2	0.011	0.008	1.423	0.155
<i>Default</i>	0.546	0.270	2.020	0.043
<i>Inflation</i>	-0.009	0.120	-0.082	0.934
<i>Term</i>	-0.258	0.138	-1.869	0.062
<i>T-Bill</i>	-1.842	1.705	-1.080	0.280
<i>Div. Yield</i>	2.566	2.830	0.906	0.365
Panel C				
Regime 1: Economic Expansion				
a_1	0.0103	0.0057	1.792	0.073
<i>Default</i>	0.488	0.248	1.971	0.049
<i>Inflation</i>	-0.0228	0.0366	-0.62287	0.533
<i>Term</i>	0.392	0.211	1.858	0.063
<i>T-Bill</i>	-1.052	1.743	-0.603	0.546
<i>Div. Yield</i>	-2.082	0.962	-2.164	0.030
Regime 2: Economic Recession				
a_2	0.027	0.017	1.544	0.123
<i>Default</i>	3.3888	0.6693	5.06301	0.000
<i>Inflation</i>	0.236	0.104	2.265	0.023
<i>Term</i>	1.974	0.653	3.020	0.002
<i>T-Bill</i>	-6.483	5.161	-1.256	0.209
<i>Div. Yield</i>	-6.475	3.504	-1.847	0.065

This table shows the parameter estimates and their t-statistics from the estimation of the STAR model used to model the US small-cap premium. The regime-switching model was estimated using the monthly returns of the DFA small-cap premium for the period January 1926–December 2013. The financial and macroeconomic explanatory variables are the default corporate bond, inflation, term structure, 1-month T-bill rate and the dividend yield on the S&P500. Significant coefficients of the risk factors are marked in bold.

Table 3 US small-cap premium—STAR model. Panel A: January 1926–December 2013, Panel B: January 1970–December 2013, Panel C: January 1926–December 1969.

Panel B of Table 3 shows the corresponding results of the estimates for the shorter sample time period. The results show that the US default risk premium is the sole risk factor that continues to affect strongly the US small-cap premium, independently of the economic regimes, for this more recent time period: The coefficients for the default premia are significant under both economic phases (0.591 and 0.546), while none of the coefficients of the other risk factors remain undistinguishable from zero.

Panel C of Table 3 shows the results for the subsample January 1926–December 1969. These results are similar to the ones in the full sample, in which the default risk remains a significant factor on the behaviour of the US small-firm premium. However, the dividend yield factor is related to the premia only under the expansionary regime, while the inflation and term risk factors have an impact only under the phase of weak economic conditions.

These previous US results corroborate those of [Perez-Quiros and Timmermann \(2000\)](#) in that the default risk premium is mostly important in the excess return equation during economic recessions and particularly so for small firms. However, the authors found that the small firms' excess returns are most strongly negatively correlated with the short interest rate in the recession state, while in this study, the short-term interest rate does not affect the small-cap premium under any of the two economic regimes. Finally, [Perez-Quiros and Timmermann \(2000\)](#) assumed that the dividend yield risk factor in the return equation is not state-dependent, while this paper shows that this premium is related to the US small-firm premium when the economy achieves strong growth.

5.2. Empirical Results for the Canadian Small-Cap Premium

The United States is and has, for the past century, been the world's largest economy and, because of its proximity with Canada, has a tremendous impact and influence on the northern neighbor's economy. For these reasons, the Canadian small-cap premium was investigated in relation to both Canadian and US risk factors.

Table 4 shows the empirical findings when examining the Canadian small-cap premium under the STAR model and relative to its various risk factors. Panel A shows that both the US term premium (t-statistic of 2.034) and the US default premium (t-statistic of 3.81) are shown to significantly affect the Canadian small-cap premium under the expansionary economic phase. On the other hand, during economic recessions (Panel B), the Canadian T-bill rate (t-statistic of 3.728), the US default spread (t-statistic of 3.822) and the US T-bill rate (coefficient 2.603) significantly affect the Canadian small-cap premium.

It is interesting to note that the Canadian default spread factor plays no role on the dynamics of the Canadian small-cap premium over the period analyzed. By contrast, the US default risk exposure appears to tremendously influence the return differential between large-cap and small-cap firms and that this effect is not related to the economic activity phases: The US default risk coefficients are strongly significant under both regimes. A possible explanation for this outcome would be that Canadian small firms export mainly to US companies, and hence, when the level of bankruptcy increases in those latter firms, small Canadian companies suffer from this lesser degree of activity.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Panel A				
Regime 1: Economic Expansion				
a_1	-0.082	0.120	-0.680	0.496
<i>CDN Default</i>	0.419	0.298	1.340	0.161
<i>CDN Inflation</i>	0.167	1.419	0.118	0.906
<i>CDN Term</i>	-0.172	0.211	-0.812	0.417
<i>CDN T-Bill</i>	0.128	0.226	0.569	0.567
<i>CDN Div. Yield</i>	-0.048	0.412	-0.117	0.906
<i>US Default</i>	2.169	0.569	3.81	0.000
<i>US Inflation</i>	0.879	1.286	0.683	0.494
<i>US Term</i>	2.147	1.055	2.034	0.042
<i>US T-Bill</i>	0.377	0.270	1.393	0.163
<i>US Div. Yield</i>	0.193	0.246	0.787	0.431
Panel B				
Regime 2: Economic Recession				
a_1	-0.59	0.199	-1.052	0.293
<i>CDN Default</i>	5.202	11.125	0.467	0.640
<i>CDN Inflation</i>	4.702	0.415	1.386	0.166
<i>CDN Term</i>	0.575	0.410	1.386	0.166
<i>CDN T-Bill</i>	1.180	0.316	3.728	0.000
<i>CDN Div. Yield</i>	0.237	0.736	0.322	0.747
<i>US Default</i>	0.079	2.636	3.822	0.000
<i>US Inflation</i>	0.963	1.575	-0.611	0.541
<i>US Term</i>	-1.42	1.370	-0.104	0.917
<i>US T-Bill</i>	0.901	0.346	2.603	0.009
<i>US Div. Yield</i>	-0.092	0.301	-0.307	0.758

This table shows the parameter estimates and their t- from the estimation of the STAR model used to model the Canadian small-cap premium. The regime-switching model was estimated using the monthly returns differential between the Nesbitt Burns small-cap return index and the returns of the S&P TSX for the period January 1970–December 2013. The financial and macroeconomic explanatory variables are the Canadian and US default corporate bond, inflation, term structure, 1-month T-Bill rate and the dividend yield described in more detail in Section 4. Significant coefficients of the risk factors are marked in bold.

Table 4 Canadian small-cap premium—STAR Model. Panel A: January 1970–December 2013. Panel B: January 1970–December 2013.

6. Conclusions

Since at least 1981, when Banz (1981) presented empirical evidence that small-cap stocks generated higher average returns than larger firms, a plethora of studies has emerged on the small-firm effect to investigate the validity and persistence of the small-cap premium and to offer explanations for the empirical outperformance of small-cap stocks over the long term. While the small-firm premia in the US and Canada are on average economically sizable over the long term, they also exhibit considerable time-varying properties, which are shown to be linked to the business cycle.

The conventional explanation for the small-cap premium is that it represents a systematic risk premium that needs to be incorporated into practicable asset pricing models. Academics do not suggest that firm size per se is the

source of the risk driving the dynamic of expected returns, but that size is a proxy for one or more underlying risk factors associated to smaller firms. Some fairly robust relationships have been uncovered between the small-firm effect and default risk, as well as between the small-firm effect and several macroeconomic variables.

This paper contributes to the extensive literature that has investigated the links between the small-firm premium and various financial and macroeconomic variables using nonlinear regime-switching models. The paper highlights that the US default risk affects the return differential between large-cap and small-cap firms in both Canada and the US and that these relationships are independent of the economic activity phases.

These results are important for policy makers, portfolio managers and academics. The framework for dynamic asset allocation decisions can clearly be enriched by incorporating regimes with specific and, in some cases, independent financial and macroeconomic risk exposures. Forecasting regime shifts that reflect the changing nature of the risk and return opportunity sets will also be invaluable and remains a topic for future work.

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Appendix A

Appendix A.1. Default Risk Factor

The relationship between stock returns and default risk has important implications for risk–reward trade-off in financial theory: If default risk is systematic, then investors should demand a positive risk premium for not being able to diversify this risk. This argument is consistent with the contention that financial distress should be considered as a missing factor to the CAPM. A positive default risk premium reflects the desire of investors to hedge against unanticipated increases in the aggregate risk premium prompted by economic slowdowns (Ferson and Harvey, 1991). Fama and French (1995) suggested that the small-firm premium is a proxy for a default risk factor. Beck and Demircuc-Kunt (2006) stressed that small- and medium-size companies are more subject to default risk than large firms because of their lack of capital and liquidity.

While financial theory is in accordance with a positive premium for the default risk, the empirical literature provides mixed conclusions on the relationship between stock returns and default risk. Chen et al. (1986) found a positive factor loading on the risk premium and claimed this sign is caused by investors who want to hedge against unanticipated increases in the aggregate risk premium occasioned by an increase in uncertainty. Chan and Chen (1991) showed that financial distress cannot be diversified away, causing investors to command a premium for bearing such a risk. Denis and Denis (1995) presented evidence that default risk is associated to macroeconomic factors and that it varies with the business cycle. Vassalou and Xing (2004) presented results showing that small firms have a much higher default risk than large firms. After controlling for the Fama–French factors, Campbell et al. (2008) provided evidence that distressed firms generate lower returns than nondistressed firms. Their results challenge the intuition that higher risk should be rewarded by higher returns and suggest that the size and value factors of by Fama and French’s model (1993) cannot completely capture default risk and put it toward a missing factor that could be associated to default risk. Garlappi et al. (2008) applied expected default frequencies (EDF) from Moody’s KMV and document that stock returns are not positively related to distress risk but are unable to find evidence of a negative premium. Da and Gao (2010) presented evidence of a positive relationship between default risk and returns.

In sum, from an efficient markets risk perspective, the association between default risk and the small-cap premium remains ambiguous, based on standard linear model approaches. This paper tries to shed new light on this issue using nonlinear approaches.

Appendix A.2. Term Structure Risk Factor

Term structure risk is also incorporated as a possible factor influencing the small-cap premium. It is well known that the slope of the yield curve typically reflects the state of the business cycle.⁵ A positive slope of the yield curve is usually associated with a future increase in real economic activity. Two reasons are often suggested for this relationship between the term structure and economic conditions.

First, when the yield curve is positively sloped, banks have an incentive to enlarge their balance sheets, i.e., borrow short, lend long and increase the money supply. Small-cap firms are critically dependent and sensitive to this funding supply because of their need to finance their daily operations and future projects.

Second, there exists also a production-side explanation to the sensitivity of small firms to the term structure. If corporations expect an economic upturn in the longer horizon, capital projects will become more attractive, because revenues and cash flows are usually positively correlated with business cycles. Given that firms generally attempt to match the maturity of the financing of a project to the life of the project, this increases the demand for long-term financing, which will be in turn reflected in higher long-term interest rates.

A positive term premium signals favourable economic prospects—hence, this variable may be hypothesised to have a positive effect on the small-cap premium for both expansionary and recessionary regimes. The effect might be considered to be more important during recessionary periods, to the extent that an increasing slope of the term structure serves as an indicator of improved economic conditions that are forthcoming. For these reasons, we hypothesize a positive sign for the term structure risk factor when the small-cap premium is regressed on this explanatory variable.

Appendix A.3. Inflation Risk Factor

The Fisher effect (Fisher, 1930) states that expected nominal rates of interest on financial assets should move one-to-one positively with expected inflation because equities are assumed to be an effective hedge against inflation. However, Fama (1981) proposed a theoretical explanation for a negative correlation between stock returns and inflation. In this approach, an increase in inflation causes a decrease in real economic activity as well as money demand. This reduced economic activity negatively affects firms' future profits, leading to a decline in share prices. Boudoukh and Richardson (1993) and Bekaert (2010) also asserted that inflation risk undermines the performance of investments and has a negative impact on stock returns.

Since small firms usually operate in competitive business environments, they may have less pricing power than larger companies and, hence, may be more exposed to inflation uncertainty, which leads to a greater inflation premium exposure relative to larger firms.

For these reasons, this paper hypothesizes a negative effect for inflation risk on the small-cap premium.

Appendix A.4. Short-Term Interest Rate Risk Factor

The finance literature commonly includes the one-month T-bill rate as a state variable to proxy for investors' (unobserved) expectations of upcoming economic conditions. Moreover, because the short-term rate is also a barometer of the market wide interest rate, it acts as a proxy for firms' interest expenses, an important indicator of tighter credit market conditions in accordance with the imperfect capital market theories. Fama and Schwert (1977), Campbell (1987) and Glosten et al. (1993) employed this explanatory variable in stock return equations and showed that it is negatively correlated with subsequent returns.

⁵Over the business cycle, during periods of economic expansion when demand for funds increases, interest rates normally rise, with short-term rates rising faster than long-term rates. When short-term rates are below long-term rates, the yield curve has a positive slope. As a cyclical peak approaches, short-term rates may rise above long-term rates, and the yield curve will invert, taking on a negative slope. When a recession follows the cyclical peak, rates begin to fall, with short-term rates normally falling faster than long-term rates. Eventually, this should again lead to a positively sloped yield curve. Thus, the spread between long-term rate and short-term rate, or term premium of interest rates, changes as the economy goes through various cycles. See, e.g., Park and Switzer (1996).

Appendix A.5. Dividend Yield Risk Factor

Although it is not directly linked to credit market conditions, the dividend yield risk factor is normatively and commonly used in the literature to model expected returns (Fama and French, 1988). The general explanation for the occurrence of this regressor is that it proxies for time variation in the unobservable risk premium, since a high dividend yield implies that dividends are being divided at lower stock prices.

This table shows the results of the Teräsvirta (1994)'s approach to first test for linearity of the small-cap premiums in the US and Canada. If the hypothesis of linearity is rejected and H_{03} is accepted, while H_{12} is rejected, then the specification will point toward an ESTAR instead of a LSTAR model. Panel A provides the estimates for the US over the period January 1926 through to December 2013; panel B shows the results for both the US and Canada over the period January 1970–December 2013.

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