Price Discovery in the Cross Listed Stock Market: Revisiting the Case of Canadian Stocks Listed in the United States

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ABSTRACT

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This paper revisits studies conducted by Rosenthal and Young (1990) and Froot and Dabora (1999) that found prices of twin stocks to be mispriced and that this mispricing could be explained by the markets in which the shares are listed. Our study investigates whether these findings can be generalized to Canadian firms who cross-list in the US. Using a sample of 184 firms who cross-listed during the period 1975 – 2013, we also observe share mispricing that can be explained by the markets in which the shares are listed in, however it is not trading activity alone that determines the significance of this relationship. Furthermore, we observe a discrepancy in the co-movement of Canadian-listed shares and their US-listed counterparts with currency fluctuations, making this the most significant factor in explaining the mispricing observed in our sample of cross-listed firms.

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Introduction

This thesis revisits the results of Rosenthal and Young (1990) and Froot and Dabora (1998) that suggest that prices of stocks that are listed in different markets tend to move more with the markets in which they experience greater trading volume. The authors of these studies used twin stocks to demonstrate that there existed significant mispricing in the pricing of seemingly identical shares, trading in separate markets.[1] Our contribution lies in providing a fresh look at this phenomenon using a more robust and relatively longer sample period. While Rosenthal and Young (1990) examined two pairs of twin stocks, Froot and Dabora (1998) simply extended this study by adding an additional pair. Apart from the issue with the very small sample, these studies also suffer from two other potential drawbacks. First, the twin pairs traded in temporally separated markets, these could potentially distort the measurement of comovement among them. Second, the twin pairs traded as distinct assets, thereby making it extremely difficult to arbitrage any price distortion.[2] . We overcome these concerns by using a set of cross listed Canadian firms trading on the Toronto Stock Exchange and either the NYSE, Nasdaq

[1] Twin stocks arise from an agreement between two companies to combine through a merger, while still retaining their distinct legal identities and existing share listings. In such an agreement each entity is entitled to some fixed proportion of the combined entity.

[2] An example of this is the case of Royal Dutch and Shell, who merged in 1907 but chose to remain distinct companies. Due to the ownership structure at the time of the merger, Royal Dutch was granted claims to 60% of the combined cash flows, with the remaining 40% being allotted to Shell. While each company retained their existing shares, the implications of the merger were that Royal Dutch shares be priced at 1.5 times the shares of shell. Historically this has not been the case, however because the shares are distinct from one another, they are not interchangeable and hence cannot easily be arbitraged.

or Amex. This allows us to examine a larger sample, trading on two markets located in the same time zone. The stocks of cross listed firms can be easily purchased on one market and sold on the other, thereby enabling arbitrage.

Over the last several decades financial markets have become increasingly integrated, resulting in the globalization of capital flows. This globalization has facilitated the process by which firms raise capital globally and the ability for investors to access and process information regarding foreign-listed firms. Due to decreased barriers, both regulatory and technologically, firms can list across several different markets, gaining access to world-wide investors. Moreover, investors are much more prone and less averse to invest in foreign companies than in the past, due to better access to information and the increase in the efficiency and integration of financial markets as a whole.

A substantial amount of literature has focused on addressing questions regarding how markets determine equilibrium prices for inter-listed firms and furthermore how the location of trade affects this process. However the conclusions of this literature vary significantly depending on the markets studied and the time periods examined. Many studies have found evidence suggesting that it is generally the home market of a cross-listed firm that dominates the price discovery process, while the foreign market only plays a limited role (Kato et al., 1990; Solnik, 1996; Lieberman et al., 1999; Kim et al., 2000; Bacidore and Sofianos, 2002; Wang et al., 2002; Grammig et al., 2005; Agarwal, Liu, and Rhee, 2006). However, there also exist numerous studies that find the foreign market's contribution to be rather significant (Ding et al., 1999; Hupperets and Menkveld, 2002; Eun and Sabherwal, 2003;

Phylaktis and Korczak , 2004). Grammig, Melvin and Schlag (2007) show that for international stocks that cross-list on a US exchange, the home and foreign market's contribution to a stock's price discovery will differ from one firm to another. The authors present evidence suggesting that these differences can be explained by the liquidity of a given firm. This implies that a firm trading more in a foreign market will tend to have a greater portion of its price discovery process derived in that market in comparison to a firm whose majority of trading takes place in the home market.

It has also been hypothesized in previous research that equity prices for firms that list abroad will tend to be mispriced and that this can in part be explained by the tendency of such stock prices to move more with the markets in which they trade the most. Rosenthal and Young (1990) found precisely this by examining two groups of twin stocks (Royal Dutch Petroleum and Shell Transport and Trading, PLC and Unilever N.V. and Unilever PLC). Their findings were then supported in a later study, conducted by Froot and Dabora (1998), who examined the same two groups along with SmithKline Beecham. Gagnon and Karolyi (2005) also show that stock prices of firms cross-listing into the US deviate from parity due to co-movement with the home and foreign markets. They suggest that their findings reflect institutional and informational barriers to arbitrage. The results of these studies are in line with the stream of research claiming that the share of price discovery of the home and foreign markets of a dual-listed firm is greatly associated with the share of trading in each respective market. Consequently, they also contradict the findings that the home market dominates in a cross-listed firm's price discovery.

In taking a closer look one immediate issue is that much of the existing literature draws these conclusions using intraday prices. In fact, it is primarily this group of studies using higher frequency data that find evidence of any significance for the share of price discovery of the foreign market. A potential pitfall here is the level of noise that occurs throughout the day. Noise introduced by high frequency trading has been found to distort the estimation of financial measures[3]. Another issue is that a large amount of the discussed research has involved temporally separated markets. Given the prevalence of aftermarket trading along with a continuous price discovery process, the difference in the timings that prices are observed in each market could be rather significant. This applies particularly to Rosenthal and Young and Froot and Dabora's research. An additional concern with these two studies is that they look at the prices of shares that while are dually listed, trade as separate entities. In effect, it is not as straight forward to arbitrage misprices between twin stocks as one cannot simultaneously take long and short positions in the same share in different markets. This concern is especially relevant for uninformed, less-sophisticated investors who make up a large part of the market. This could potentially explain why any mispricing of twin stocks persist over a relatively long time period.

We address these concerns by proposing the use of cross-listed stocks instead of twin stocks for exploring the phenomenon observed by Rosenthal and Young (1990)

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[3] See for instance Ebens (1999), Andersen, Bollerslev, Diebold and Ebens (2001), Banrdorff- Nielsen, Hansen, Lunde and Shephard (2004, 2008b), Hansen and Lunde (2004a), Hansen and Lunde (2004b), Bandi and Russell (2005a), Zhang, Mykland and Ait-Sahalia (2005), Andersen, Bollerslev, Diebold and Labys (2006) , Andersen, Bollerslev and Meddahi (2011), Ait-Sahalia and Xiu (2016)

and Froot and Dabora (1998). We use a set of 184 cross-listed Canadian stocks, trading on the Toronto Stock Exchange, and cross listed on the NASDAQ, NYSE or AMEX during the period spanning 1975 to 2013. We use daily closing prices for our analysis instead of intraday prices, which are more likely to be noisy.

What we find is that Canadian cross-listed stock prices do deviate significantly from parity and that for many stocks this can be explained by the co-movement of prices with the equity indices where they are listed. The effect of the home market is greater than the effect of the foreign market. We also find that the contribution of the home market in explaining mispriced cross-listed stocks is greater for large firms than it is for small firms. Furthermore, we observe that the foreign exchange rate is the most significant factor in explaining the mispricing observed in our sample of cross-listed firms.

The remainder of the paper is organized as follows. Section 2 provides a comprehensive review of the existing literature. In Section 3 we present our empirical hypothesis. Section 4 describes the data. In Section 5 we provide the results of the study along with a discussion. Section 6 concludes the paper.

Literature Review

This paper extends the findings of Froot and Dabora's (1998) study, which investigates how prices of twin stocks, listed on different exchanges, are affected by the markets in which they trade. Specifically, the authors look at three different groups of 'Siamese twin' company stocks – that is, dual-listed corporations that usually result from two entities combining through a merger but with each entity retaining its own legal identity. Although publicly listed shares of the separate entities remain distinct from one another, the value of each twin is obtained by pooling all current and future equity cash flows of the parent company and dividing them proportionally using some constant proportion such that, shareholders of the separate entities actually own a portion of the combined corporation. They share the risk of both firms and they have claims to all cash flow distributions and voting rights in both firms. Thus, one would expect the shares of the firms to trade such that the ratio of their relative prices reflect the ratio of their allocated claim on the parent company's cash flows. Moreover, one would especially expect these prices to move in unison with one another. An earlier study by Rosenthal and Young (1990) investigated whether this was the case for two groups of dual-listed firms, Royal Dutch Petroleum and Shell Transport and Trading, PLC and Unilever N.V. and Unilever PLC. The authors found that the share prices of the twins in both groups were significantly mispriced and the ratios of the prices were not representative of the proportion of assets allocated to one firm relative to the other.

As an extension of Rosenthal and Young (1990), Froot and Dabora (1998), examined the same two groups together with SmithKline Beecham and hypothesize that the relative prices of dual-listed firms will be significantly influenced by the markets in which each twins' trading activity is higher. The results of their study, support the findings of Rosenthal and Young (1990). They show that there is indeed an issue of mispricing in the twins' shares and that this mispricing can in part be explained by movements in the markets in which a twin trades most actively.

Like dual-listed firms, cross-listed shares also trade on multiple exchanges. However, unlike dual listed firms, cross listed securities are issued by one legal entity looking to list in different markets. Over the past several decades, numerous studies have examined various topics in relation to cross-listed firms, mostly focusing on the motivations behind the decision to list in a foreign market, the performance of such firms, and, whether the assumed benefits associated with listing in foreign markets are indeed realized. The primary objective for cross listing is increased exposure for firms outside of their domestic markets (Baker et al., 2002). This is associated with bringing additional analyst and news coverage, decreasing agency costs (Stulz, 1999; Coffee, 2000), attracting more investors, and increasing liquidity (Karolyi, 1998). Extant research finds evidence supporting, cross-listing lowers a firm's cost of capital (Hail and Leuz, 2006), reduces earnings forecast errors (Miller, 2003) and enhances firm performance (Doukas and Switzer, 2000).

Focusing on the US, it is well documented that US investment in foreign firms is substantially greater for firms that list shares on a US exchange than it is for firms that do not. Ahearne, Griever, and Warnock (2004) show that the *home bias* – the phenomenon that investors largely overweight domestic stock allocation relative to the portion allocated to foreign securities – would be significantly reduced if all foreign firms would cross-list into the US. The authors claim that their findings can be explained by a reduction in information costs that investors face when investing abroad.[4] Ammer, Holland, Smith and Warnock (2012) conduct a more rigorous

[4] See Bradshaw, Bushee, and Miller [2004], Edison and Warnock [2004], Aggarwal, Klapper, and

study and show that, after correcting for selection bias, being publicly listed on a US exchange is the principal determinant of the amount of US investment a foreign firm obtains and is associated with an increase in average US holdings of as much as two to three times that which would be realized without the cross-listing. More relevant to the topic of this paper is that the authors show that US investors will typically trade the foreign securities in their home market rather than through the US exchanges. Supporting this, Smith and Sofianos (1997) report an observed increase in trading volume in the home market for foreign firms after cross-listing on the NYSE. An implication of this is that increased trading volume in one market relative to the other does not provide information regarding the source of the investor base and so it is possible that mispricing between two security prices may not be necessarily related to the trading volume of the shares, but rather be attributed to the trading activity of the firm's investor base.

An important question arises here regarding the process by which markets determine equilibrium prices for cross-listed firms, or in other words the price discovery process, and the roles played by the home and foreign markets in arriving at these prices.[5] Solnik (1996) and Bacidore and Sofianos (2002) argue that it is the home market that should primarily drive the stock price discovery process, as this is where information regarding the firm originates. While information does indeed emanate domestically, the exchange an investor ultimately trades on will depend on other factors such as liquidity and pricing as well as foreign exchange related

Wysocki [2005], Ferreira and Matos [2008], and Kho, Stulz, and Warnock [2009] for additional studies showing that cross-listing results in greater US investment.

[5] As defined by Schreiber and Schwartz (1986)

considerations, such as systematic risks and trading fees. For example, an investor may prefer to trade specifically in a given market to have exposure to that market's currency or to avoid exposure to that of the alternative market. Karolyi and Stulz (2002) discuss in detail how exchange rate dynamics and foreign stock markets impact an asset's demand and pricing and find both factors to be important, particularly foreign exchange rate considerations. The authors attribute this to cross-country correlations and equity flows, and argue that their volatility over time increases the importance that global markets have on the price discovery process of an asset. Various studies have investigated whether changes in security prices are a result or the cause of capital flows. Brennan and Cao (1997) claim that international investment flows can be explained by the manner in which information and news impacts foreign investors in comparison to local investors. Foreign investors will value and react more to information due to their informational disadvantage relative to domestic investors and as a result their investment behavior in foreign assets will exhibit greater volatility. The authors also confirmed earlier findings of Tesar and Werner (1994, 1995) of contemporaneous correlations between returns and capital flows. Later research presented significant evidence however that more often than not, flows lag returns (Bohn and Tesor, 1996). Froot, O'Connell, and Seasholes (2001) examine 44 different countries from 1994-1998 and find that flows can predict returns in most cases with the exception of developed markets. This hints that within developed markets such as the US and Canada, international investors will make investment decisions such that they are reacting to an asset's returns rather than driving them. This is important because, as discussed earlier, cross-listing increases US investment activity significantly and so in consequence, if it was found that foreign investors' purchasing behavior drives assets returns, the greater a firm's US investor base then the greater the potential influence of the US market on its prices.

Prior research results are somewhat mixed. Several studies provide evidence consistent with Solnik (1996) and Bacidore and Sofianos' (2002) assertions that the home market drives an asset's price discovery, even when the cross-listing takes place in the US, the world's largest, most liquid and competitive market. Kato, Linn and Schallheim (1990) look at 23 firms listed on the NYSE, from the UK, Japan and Australia and conclude that price discovery of these firms takes place in the home market. Lieberman et al. (1999) find the same behavior in five of six Israeli firms also listed in the US, as do studies by Pascual, Pascual-Fuster and Climent (2006), and Su and Chong (2007) looking at NYSE listed firms cross-listed from Spain and Hong Kong, respectively. Grammig, Melvin and Schlag (2005) examine three German firms listed on the NYSE and come to the same conclusion. They later extend this study to include firms from Canada, France, Germany, and the U.K. with secondary listings in the U.S. and investigate these firms' price discovery during overlapping trading hours of both exchanges (Grammig, Melvin and Schlag, 2007). The overall results show that the home market is indeed the primary market, however, the authors find that there are exceptions that increase the NYSE's role in a firm's price discovery – all of which are associated to a firm's liquidity in the US relative to that in the home market. In short, the study shows that firms with greater sales and/or greater trading activity in the US relative to their domestic market will exhibit greater price discovery contribution on the NYSE. While many studies typically use models that derive links between prices that have been converted to one currency using foreign exchange rates, the authors employ a model that allows for observing effects of currency rate changes independently, claiming that the alternative method creates a bias with reference to determining true causality and that this bias increases with exchange rate volatility. Consistent with the observation of home markets dominating price discovery, the results show that foreign exchange shocks affect the home market first and cause the US prices to adjust afterwards. Nonetheless, this relationship is reversed for the firms with larger NYSE price discovery contribution..

Similarly, a study by Huppert and Menkveld (2002) observed that, for a sample of Dutch firms cross-listed on the NYSE, the roles of the home and foreign market exchanges on the price discovery process varied from one company to another. Eun and Sabherwal (2003) examine TSE listed stocks who cross-listed on a US exchange and also found the contribution of each market to vary significantly. Although the home market did dominate in the majority of cases, firms that exhibited greater US trading activity and/or competitiveness (measured by the ratio of spreads between both exchanges) had a larger portion of price discovery coming from the foreign market.

Evidently, the observations of past research vary greatly. One such factor which this may be attributed to the timing of the samples studied. As evidence, Harris, McInish and Wood (2002) showed that the NYSE's contribution to the price discovery of foreign securities varied depending on the time period examined and that this variation was due to changes in the competitiveness of the US exchange over time. Another relevant factor is surely the differences in the integration between the markets studied. Several studies have examined the integration between US and Canadian markets and the majority have found the markets to be highly integrated (Bracker, Docking and Koch, 1999; Carmichael and Samson, 1996; Normandin, 2004; Kryzanowski and Zhang, 2002). It will be interesting then to investigate Froot and Dabora's hypothesis to see if they generalize to all cross-listings over a substantial period of time in a well-integrated market.

Empirical Hypothesis

Following Froot and Dabora, we hypothesize that, changes in the relative prices of a cross-listed firm should be uncorrelated with market shocks and currency rate changes. As these are essentially the same shares, simply trading on two different markets, the returns should be identical and market shocks from the home or foreign market as well as currency changes should have an identical impact on both returns. The alternative hypothesis being tested is that return differentials can be explained by relative market shocks.

The study replicates Froot and Dabora's methodology to test for this. The model specification is:

$$r_{CN-US,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t \qquad (1)$$

That is, the log return differentials of the stock prices (return in the Canadian market minus the return in the US market) are regressed on the US and Canadian market log returns along with log USD/CAD currency changes. The model is tested separately for each firm in the sample. All tests are conducted using daily closing prices and span a period of one year following the cross-listing date.

Under the null hypothesis, all coefficient estimates should be zero. This follows from the notion that in an efficient market, as dictated by the law of one price, cross-listed shares should move in unison and exhibit identical sensitivities to market-specific shocks. The alternative hypothesis in this study is that the greater the trading activity of a stock in a given market, the greater its sensitivity to shocks in that same market. In other words, coefficient slopes should be higher for the respective markets that firms trade more on. Specifically, under this hypothesis, if a Canadian firm cross lists into the US, the price of the stock trading in the US market should move more with the US market index than the price of the Canadian stock, and the price of the stock trading in Canada should move more with the Canadian market than its foreign listed entity. Froot and Dabora claimed that for their twin stocks, the return differential of say stock A relative to stock B (stock A return minus stock B return) would exhibit a positive coefficient estimate on the market that stock A traded more on and a negative coefficient on the index that stock B traded more on. Extending this logic to the cross-listed sample in this study, we would expect positive coefficients on the Canadian market index and negative estimates for the US market factor.

We employ independent Sample t-tests to compare the estimate coefficients obtained from the above regression model. For the US market beta, we test the following null and alternative hypothesis pairs:

$H_{0,1}$: *The average US market regression coefficient estimate is not significantly less than zero.*

$H_{1,1}$: *The average US market regression coefficient estimate is significantly less than zero.*

Similarly, for the Canadian market beta, we test:

$H_{0,2}$: *The average Canadian market regression coefficient estimate is not significantly greater than zero.*

$H_{1,2}$: *The average Canadian market regression coefficient estimate is significantly greater than zero.*

A question that arises now is how the volume traded in one market relative to the other affects the impact of these factors on the return differential of a cross-listed firm's share price, while also taking into account each market's contribution to the firm's price discovery process. As previously discussed, past research has found that a Canadian firm, dually listed in the US, will have most of its price discovery originating from the home market, and that the contribution of the US market becomes relevant for firms with significant trading activity and/or sales in the US.

To investigate this, total volume traded over the year in each market is estimated from the available daily trading volumes, for each firm. We compute the ratio of volume traded in the US relative to volume traded in Canada. This provides a relative measure of trading intensity of stock in the US versus the Canadian market. In effect this represents a comparison of the annual turnover ratio for each firm, which is the total number of shares traded in each respective market throughout the year divided by the average market capitalization for that same year.

$$Turnover_{US/CN} = \frac{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{Avg\ Market\ Cap}}{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}{Avg\ Market\ Cap}} = \frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}$$

This is justified since the market capitalization, determined by multiplying share price by shares outstanding, for a given firm should be the same in either market as since it is the same shares that are trading in both the Canadian and US market and the prices of these shares should be identical, after factoring in currency rates of course.

The firms are then ranked according to this turnover ratio measure and separated into quintiles. We then conduct t-tests for each quintile on each of the three factors. Assuming Froot and Dabora are correct, we should see that the firms trading relatively more in the home market exhibit positive, larger and more significant coefficient estimates on the Canadian market index beta, while firms trading more in the foreign market have negative, larger and more significant estimates on the US market index beta.

We then perform the same type of analysis but we split the sample into quintiles according to firm size, as measured by market capitalization. The goal here is to investigate whether we can find any sort of relationship between the size of the firm and the level of co-movement with the respective markets in which the firms are listed.

With respect to the currency factor, Froot and Dabora point out that it is preferred to use the additive decomposition property that allows for the log dollar return on a foreign stock to be expressed as the sum of the local-currency log stock return and the log currency change so that each factor is expressed as its own coefficient. The authors argue that this avoids measurement error in one of the two variables being induced into the other. Moreover, keeping the two factors separate allows for the additional benefit of being able to observe what portion of any sensitivity of return differentials is attributed to currency changes versus what is explained solely by market changes, as opposed to viewing the combined impact of both factors as one. As explained by the authors, "For example, if local residents drive up the local-currency value of local stocks (caused by, say, a decline in risk aversion or by noise), they may drive up the price of the 'home' twin relative to the 'foreign' twin. We would therefore expect to find a positive beta on the appropriate local-currency stock index in Eq. (1). But, changes in the local currency may be driven by entirely different factors, so that the beta on the currency change could be zero" (Froot and Dabora, 1999, p. 197).

Data

We begin with a sample that is restricted to Canadian firms listed on the TSX that cross-listed on one of the three major US exchanges - NYSE, NASDAQ or AMEX – at any point during the period spanning 1950 to 2013 for which Compustat contains data. We find 337 such companies. Canadian stock price and volume are obtained from the Canadian Financial Markets Research Centre (CFMRC) and US data from the Center for Research in Security Prices (CRSP). We drop firms for which data is unavailable in either database. CFMRC only provides data as far back as January 2nd, 1975 and as a result an additional 21 firms are removed from the sample. Of the remaining 234 companies, only firms that remained cross-listed for a minimum period of one year are retained in the sample. For 49 of these firms there is an issue that arises where either CRSP or CFMRC does not contain data during the cross-listing period. After removing these firms we are left with a sample of 185 companies. For the second part of the analysis, where we separate the firms based on the share turnover ratio measure, an outlier is identified with a ratio of 332.14, while the largest ratio of the other 184 firms is 27.09. Consequently, the outlier is omitted and there remain 184 firms for which we are able to run the regression model described in the methodology section.

For the US and Canadian market, log returns are computed using the S&P 500 and S&P/TSX Composite Index daily prices, respectively. Currency rates are obtained from Bloomberg and represent the daily fixing USD/CAD rate.

Results and Discussion

Table 1 presents a descriptive analysis of the sample broken up over three periods. The second column of the table provides the number of cross-listings in the data that occurred in the time period specified in the adjacent column. Columns two and three give the average and median firm sizes, respectively. It is evident that the number of Canadian firms cross-listing into the US grew substantially after 1991, as 87 of the total firms in our 184 firm sample cross-listed between 1991 and 2000 and 70 firms cross-listed between 2001 and 2013. Unsurprisingly, the average and median firm sizes are larger with time.

[Insert Table 1 Here]

Table 2 presents the summary of the two One-Sample t-tests. In the first row of the table we have the test results for the US market index beta coefficients, which show a t-statistic of -1.3661 and a p-value of 0.0868. Assuming a level of significance of 0.10, we reject the null hypothesis for this test, suggesting that on average the price differential of Canadian cross-listed firms do seem to depend on the US market index. In other words, prices of the shares listed on a US exchange do tend to move more with the US market than do the prices of the Canadian-listed shares. The second row of the table provides the results for the Canadian market index. Here we obtain a t-statistic of 2.7461 and a p-value of 0.0033, indicating a much stronger level of significance for rejecting the null hypothesis of the average estimates being greater than or equal to zero. This implies that, on average, the prices of the Canadian shares move more with the Canadian market index than do the prices of the US-listed shares.

[Insert Table 2 Here]

Table 3 displays the analysis where the firms are divided into quintiles determined by their share turnover in the US relative to their share turnover in Canada. Those in the first quintile are traded least in the US relative to Canada, and those in the fifth quintile are most actively traded in the US. Looking at the third row of the table, which presents the average betas on the US market index factor, and at Figure 1 where these same estimates are charted, we can see that the average coefficient estimate is approximately -0.05 for all quintiles with the exception of the third quintile who shows an average estimate closer to zero. The implications of this is that as long as the trading activity of the firm is such that it trades more in either the home or foreign market, shocks in the US market do tend to have a greater impact on the US stock price than the Canadian stock price. However, it is important to note that only about 27-28% of firms in each quintile exhibited betas that were significantly different than zero. Furthermore, the t-statistics show that we would not reject a null hypothesis of the beta estimate differing significantly from zero for any of the five quintiles.

Moving on to the second section of the table, for all quintiles we have a large and positive Canadian market index coefficient estimate. Only the first quintile results in a t-statistic such that we would not reject a null hypothesis that the average coefficient estimate is significantly different than zero. For the remaining four quintiles, while we do reject such a hypothesis, the magnitude and the significance of the average estimates does not exhibit any relationship to the trading volume of the stocks in the home market relative to that in the foreign market. However we do see the greater the turnover ratio measure (implying greater trading in the US relative to in Canada) the lower the percentage of firms with a significant beta. This implies that greater trading activity in the US market decreases the likelihood that shocks in the Canadian market impact the Canadian-listed shares more than the US-listed shares.

The third part of the table presents the results for the currency change factor. Of the three factors, this is the largest source of mispricing for the cross-listed firms in this study. A 1% appreciation of the US dollar versus the Canadian dollar should be associated with a 100 basis point difference in the relative price of the Canadian listed stock to that of the US listed stock. What we do see, is an average beta ranging from 43 to 98 basis points. The t-statistics reported in this section of the table test whether the average coefficient estimate is significantly different than 1. We reject such a hypothesis for four of the five quintiles.

It appears that it is not necessarily the trading activity that determines how movements in a given market impact the return differential between a firm's cross-listed shares, as there is no true discernible pattern in the results across the quintiles. Since our sample spans a large period of time there are other factors which may be contributing to the results, such as the change in the integration between the US and Canadian market over time.

[Insert Table 3 Here]

[Insert Figure 1 Here]

In table 4, we conduct a similar analysis however we split the firms according to firm size (measured by market capitalization) rather than turnover ratio. Intuitively, one would expect the two measures to be fairly correlated in that it is less likely for smaller Canadian firms to have a larger turnover in the US relative to their home market in comparison with larger firms. However, what we see is that for both the US and Canadian market index betas, the t-test statistics that test for average coefficient estimates significantly different from zero are insignificant for all quintiles except for the fifth one which is comprised of the largest firms. For this quintile we obtain a negative coefficient on the US market index and a positive coefficient on the home market index. These results are somewhat on the contrary to what one would expect – larger firms exhibit a greater mispricing attributed to co-movements with the respective markets that they are listed in. These are the firms that should have more analyst coverage, and a greater flow of information. One potential explanation could be the difference between the relative amount of uniformed vs informed trading of large firms compared to smaller firms. As explained by Bradford DeLong et al (1990), irrational noise traders could cause a significant divergence of prices from their fundamental values. Since large firms are more likely to attract such traders, this could cause an increase in the co-movement of the home and foreign listed shares with the home and foreign equity markets. We also see that the percentage of significant home market coefficient estimates increases with firm size. Smaller firms are less likely to be mispriced due to fluctuations in the home equity market index.

[Insert Table 4 Here]

[Insert Figure 2 Here]

Our sample spans 38 years during which the market has fundamentally changed. Therefore, we carry out our analysis over three sub-periods - 1975 to 1990; 1991 to 2000, 2001 to 2013). The results for the trading activity and size studies are presented in Table 5 and Table 6 respectively. The average betas of each quintile that are divided according to turnover ratio are plotted for the three sub-periods in Figures 3, 4 and 5. In comparing the three figures with one another as well as Figure 1 that displays the average coefficient estimates for the aggregated sample, we see that for all periods the currency factor beta is the most significant factor in explaining any mispricing in cross-listed shares. However, the significance and impact of this relationship has diminished over time. It is also evident that in all periods there does not seem to be a relationship between the impact of the US market on the relative pricing of shares in our sample and the relative trading volume of the shares in each market. In looking at Table 5, we see that in all but one case, the t-test does not reject the null hypothesis of the average US market index beta being different from zero. For the Canadian market index, it is only in the most recent period (2001 – 2013) that the t-tests show that relative share prices exhibit a significant mispricing due to shocks in the home market. Moreover, we do see a relationship between this mispricing and the turnover ratio measure. Firms in the fifth quintile, which have the largest amount of trading in the foreign market relative to the home market do not result in a t-statistic that rejects the null hypothesis of an average coefficient estimate on the home market beta that is different from zero. Additionally in the most recent period (2001 – 2013) the magnitude and number of significant estimates for the home market beta decreases as the level of trading in the US increases. So it seems that increased trading in the US market results in better flow of information originating from the home market.

Additionally, we can see that over time the average betas on foreign market have decreased and are now closer to zero and are more or less constant across quintiles. In Table 6, the results are not so different. The average US market index beta is not significantly different from zero in almost quintiles, irrespective of time period. This is with the exception of the firms in the fifth quintile (the largest) during the period 1991 – 2000. These firms exhibit an average coefficient estimate that is negative and significant. For the Canadian market index we see that in all three periods large firms exhibited a significant and positive beta. Again however, the largest most significant factor has been the foreign exchange rate. Over time, the impact of this factor has diminished and the average estimates have converged towards 1. This is most likely explained by the increased integration between markets, both equity and foreign exchange, as arbitrage opportunities are exploited with greater ease.

[Insert Table 5 Here]

[Insert Figure 3 Here]

[Insert Figure 4 Here]

[Insert Figure 5 Here]

[Insert Table 6 Here]

[Insert Figure 6 Here]

[Insert Figure 7 Here]

[Insert Figure 8 Here]

We also separate our sample according to the state of the US business cycle at the time of cross-listing. As Table 6 shows, 176 of the 184 firms in our study cross-listed during an expansionary period. What is interesting here is that the 8 firms who cross-listed during a contraction phase have larger and more significant average coefficient estimates for all three factors.

[Insert Table 7 Here]

Conclusion

This thesis extends the studies of Rosenthal and Young (1990) and Froot and Dabora (1998) and investigate whether the location of trade affects the stock prices of cross-listed firms. Our study differs from theirs primarily in that we conduct a comprehensive study on all Canadian firms that have cross-listed on a US exchange, two markets that are well integrated and are not temporally separated. The aforementioned studies on the other hand focus on two and three pairs of firms, respectively, listed in markets that operate in different time-zones and moreover trade as separate entities as they are Siamese twin shares rather than cross-listed as in the case of this study. These authors argue that a firm's share price will tend to move more with the market in which it trades the most in. We find that the US listed shares do in some cases tend to move more with the US market than their Canadian-listed counterparts however we do not find that this relationship can be explained by the trading activity in the foreign market relative to that in the home market.

With respect to the home market we do see that shares listed in Canada tend to move significantly more with the Canadian market than do the shares listed in the US. Furthermore, we observe that this does seem to be somewhat related to trading activity as the number of firms this occurs with decreases with increased trading activity in the foreign market relative to that in the home market. We also observe that such mispricing is more prominent for large firms than it is for small firms.

So while we do observe that cross-listed shares are mispriced and that these mispricing can be explained by the markets in which they are listed in, it is not trading activity alone that determines the significance of this relationship.

References:

Aggarwal, R., L. Klapper, and P. Wysocki, 2005, Portfolio preferences of foreign institutional investors, Journal of Banking and Finance 29, 2919-2946.

Agarwal, S. et al., Where does price discovery occur for stocks traded in multiple markets? Evidence from Hong Kong and London, Journal of International Money and Finance (2006), doi:10.1016/ j.jimonfin.2006.10.011

Ahearne, A., W. Griever, and F. Warnock, 2004, Information costs and home bias: an analysis of U.S. holdings of foreign equities, Journal of International Economics 62, 313-336.

Ait-Sahalia, Yacine and Xiu, Dacheng, A Hausman Test for the Presence of Market Microstructure Noise in High Frequency Data (April 9, 2016). Chicago Booth Research Paper No. 16-06. Available at SSRN: http://ssrn.com/abstract=2741911 or http://dx.doi.org/10.2139/ssrn.2741911

Ammer, John, Holland, Sara B., Smith, David C. and Warnock, Francis E., (2012), U.S. International Equity Investment, Journal of Accounting Research, 50, issue 5, p. 1109-1139.

Andersen, T. G., Bollerslev, T., and Diebold, F. X., "Modeling and Forecasting Realized Volatility."Econometrica, 71: 579625, 2003

Andersen, T. G., Bollerslev, T., Diebold, F. X., and Ebens, H., "The Distribution of Stock Return Volatility."Journal of Financial Economics 61, 43-76, 2001.

Andersen, T. G., Bollerslev, T., Diebold, F. X., Labys, P., "Realized Volatility and Correlation."Risk, 104 -108, 1999.

Andersen, T. G., Bollerslev, T., Diebold, F. X., Labys, P., "Modelling and forecasting realized volatility."Econometrica, 71, 2003.

Andersen, T. G., Bollerslev, T., Diebold, F. X., Wu, J., "Realized beta: Persistence and predictability."Advances in econometrics: 20, 1-39, 2006.

Andersen, T. G., Bollerslev, T., Meddahi, N., "Realized volatility forecasting and market microstructure noise."Journal of Econometrics Volume 160, Issue 1, Pages 220-234,
2011.

Barndorff-Nielsen, O., Hansen, P., Lunde, A., and Shephard, N., "Multivariate realised kernels: consistent positive semi-definite estimators of the covariation of equity prices with noise and non-synchronous trading."Working Paper, University of Oxford, 2008b.

Barndorff-Nielsen O. E., and Shephard N., "Econometric analysis of realised volatility and its use in estimating stochastic volatility models."Journal of the Royal Statistical Society, Series B 64: 253280, 2002.

Bandi, F. M., Russell, J. R. "Realized covariation, realized beta and microstructure noise."Unpublished paper, 2005.

Bradshaw, M. T., B. J. Bushee, and G. S. Miller, 2004, Accounting choice, home bias, and U.S. investment in non-U.S. firms, Journal of Accounting Research 42(5), 795-841.

Edison, H. J., and F. Warnock, 2004, U.S. Investors' Emerging Market Equity Portfolios: A Security-Level Analysis, Review of Economics and Statistics 84(3), 691-704.

Eun, C.S., and S. Sabherwal, 2003, "Price Discovery for Internationally Traded Securities: Evidence from the U.S.-Listed Canadian Stocks." Journal of Finance, 58, 549-576.

Ferreira, M., and P. Matos, 2008, The colors of investors' money: The role of institutional investors around the world, Journal of Financial Economics 88, 499-533.

Grammig, Joachim and Schlag, Christian and Melvin, Michael, The Role of U.S. Trading in Pricing Internationally Cross-Listed Stocks (March 2004). EFA 2004 Maastricht Meetings Paper No. 3267.

Grammig, J., M. Melvin and C. Schlag, 2005, Internationally cross-listed stock prices during overlapping trading hours: price discovery and exchange rate effects, Journal of Empirical Finance 12, 139–164.

Hansen, P. R., and Lunde, A., "Realized Variance and Market Microstructure Noise."Stanford University, 2004a.

Hansen, P. R., and Lunde, A., "A Realized Variance for the Whole Day Based on Intermittent High Frequency Data."Stanford University, 2004b.

Harris, F., T. McInish and R. Wood (2002), "Security Price Adjustment across Exchanges: An Investigation of Common Factor Components for Dow Stocks." Journal of Financial Markets 5, 341-348.

Hupperets, E., and A. Menkveld, 2002, Intraday analysis of market integration: Dutch blue chips traded in Amsterdam and New York. Journal of Financial Markets 5, 57-82.

Karolyi, G.A., Stulz, R., 2003. Are financial assets priced locally or globally. In: Constantinides, G., Harris,

Kim, M., A.C. Szakmary, and I. Mathur, 2000, "Price Transmission Dynamics between ADRs and Their Underlying Foreign Securities," Journal of Banking and Finance 24, 1359-1382.

Kato, K., S. Linn and J. Schallheim, 1990, Are there arbitrage opportunities in the market for American Depository Receipts?, Journal of International Financial Markets, Institution, and Money 1, 73-89.

Kho, B., R. Stulz, and F. Warnock, 2009, Financial globalization, governance, and the evolution of the home bias, Journal of Accounting Review 47: 597-635.

Kryzanowski, L., & H. Zhang, 2002, Intraday market price integration for shares cross-listedinternationally, Journal of Financial and Quantitative Analysis, 37(2), 243-269

Lieberman, O, U. Ben-Zion, and S. Hauser, 1999, "A Characterization of the Price Behavior of International Dual Stocks: an error correction approach," Journal of International Money and Finance 18, 289-304.

Lowenstein, Roger (2000). When Genius Failed: The Rise and Fall of Long-Term Capital Management. Random House. ISBN 0-375-50317-X.

Normandin, M., 2004, Canadian and U.S. financial markets: testing the international integration hypothesis under time-varying conditional volatility, Canadian Journal of Economics 37 (4),1021-1041.

Pascual, R., B. Pascual-Fuster, and F. Climent (2006), "Cross-listing, price discovery and the informativeness of the trading process." Journal of Financial Markets 9, 144-161.

Rosenthal, L., Young, C., 1990. The seemingly anomalous price behavior of royal dutch shell and unilever N. V./PLC. Journal of Financial Economics 26, 123-141.

Schreiber, Paul S., and Robert A. Schwartz, 1986, Price discovery in securities markets, Journal of Portfolio Management 12, 43 - 48.

Smith, Katherine, and George Sofianos, 1997, The impact of an NYSE listing on the global trading of non-U.S. stocks,Working paper 97-02, NYSE.

Su, Q., Chong, T., 2007. Determining the contributions to price discovery for Chinese cross- listed stocks. Pacific-Basin Finance Journal 15, 140-153.

Wang, S.S., O.M. Rui, and M. Firth, 2002, Return and Volatility Behavior of Dually Traded Stocks: the case of Hong Kong, Journal of International Money and Finance 21, 265-293.

Zhang, L., Mykland, P., and At-Sahalia, Y., "A Tale of Two Time Scales: Determining Integrated Volatility with Noisy High-frequency Data."Journal of the American Statistical Association. 100(472): 1394-1411, 2005

Tables & Figures

Table 1: Descriptive Statistics

This table presents the descriptive statistics for all 184 firms included in the sample for the analysis carried out in this study

Period	Number of Firms	Average Firm Size	Median Firm Size
1975 - 1990	27	307,216,886.16	106,267,979.96
1991 - 2000	87	1,012,329,337.85	250,385,782.64
2001 - 2013	70	1,482,544,215.65	366,358,265.36
1975 - 2013	184	1,087,747,844.64	253,672,616.17

Table 2: T-test Results

The table presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. This table presents the average $\beta_{S\&P}$ and the average δ_{TSX}.

The t-statistic and p-value in row 1 are for the test:

$H_{0,1}$: *The average US market regression coefficient estimate is not significantly less than zero.*

$H_{1,1}$: *The average US market regression coefficient estimate is significantly less than zero.*

The t-statistic and p-value in row 2 are for the test:

$H_{0,2}$: *The average Canadian market regression coefficient estimate is not significantly greater than zero.*

$H_{1,2}$: *The average Canadian market regression coefficient estimate is significantly greater than zero.*

	N	Mean	Std Dev	Std Error	t	p-value
S&P 500	184	-0.0352	0.3500	0.0258	-1.3661	0.0868
TSX Comp	184	0.1097	0.5418	0.0399	2.7461	0.0033

Table 3: Quintiles separated by Turnover Ratio

The table presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to average turnover ratio as measured by:

$$Turnover_{US/CN} = \frac{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{Avg\ Market\ Cap}}{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}{Avg\ Market\ Cap}} = \frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}$$

The table presents the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile along with the percentage of significant observations for each group.

The t-statistic is for the test:

H_0: *The average coefficient estimate is not significantly different than zero.*
H_1: *The average coefficient estimate is significantly different than zero.*

	Q1	Q2	Q3	Q4	Q5
# of Obs	36	37	37	37	37
Avg turnover ratio	0.0	0.3	0.8	1.9	9.8
Avg S&P Index Beta	-0.047	-0.049	0.0020	-0.052	-0.049
(t-stat)	(-0.907)	(-0.756)	(0.040)	(-1.227)	(-0.760)
% of significant obs	28%	27%	27%	27%	27%
Avg S&P/TSX Comp Beta	0.112	0.163**	0.135**	0.182**	0.163**
(t-stat)	(0.704)	(2.402)	(2.399)	(2.366)	(2.402)
% of significant obs	44%	43%	35%	24%	24%
Avg USD/CAD Beta	0.437***	0.697***	0.729***	0.968	0.697***
(t-stat)	(-3.024)	(-2.829)	(-4.330)	(-0.221)	(-3.356)
% of significant obs	69%	68%	70%	78%	57%

Table 4: Quintiles separated by Firm Size

The table presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to average firm size as measured by a firm's market capitalization.
The table presents the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile along with the percentage of significant observations for each group.

The t-statistic is for the test:

H_0: *The average coefficient estimate is not significantly different than zero.*
H_1: *The average coefficient estimate is significantly different than zero.*

	Q1	Q2	Q3	Q4	Q5
# of Obs	36	37	37	37	37
Avg firm size *(millions)*	40	150	410	1036	4998
S&P Index Beta	-0.065	-0.045	0.0030	0.022	-0.095***
(t-stat)	(-0.601)	(-0.772)	(0.061)	(0.352)	(-2.803)
% of significant obs	33%	27%	38%	32%	35%
S&P/TSX Comp Beta	0.179	0.1	0.081	0.102	0.162***
(t-stat)	(0.987)	(0.973)	(0.153)	(1.135)	(4.238)
% of significant obs	28%	19%	30%	41%	51%
USD/CAD Beta	0.078***	0.813*	0.761***	0.831	0.849***
(t-stat)	(-3.778)	(-1.925)	(-4.048)	(-1.542)	(-3.790)
% of significant obs	31%	54%	81%	78%	95%

Table 5: Time-period analysis – Turnover ratio

The table presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to average turnover ratio as in Table 3 and then also split into one of three groups depending on the year of cross-listing. We examine three time-periods: 1975-1990, 1991-2000 and 2001-2013.
The table presents the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ along with the percentage of significant observations for each group.

The t-statistic is for the test:

H0: *The average coefficient estimate is not significantly different than zero.*
H1: *The average coefficient estimate is significantly different than zero.*

		Q1	Q2	Q3	Q4	Q5
1975 - 1990	# of Obs Avg turnover ratio	5 0.1	5 0.3	5 0.5	6 0.9	6 3
	S&P Index Beta	-0.169	-0.199**	0.004	0.1034	-0.084
	(t-stat)	(-0.456)	(-4.810)	(0.3006)	(0.912)	(-0.975)
	% of significant obs	40%	20%	60%	33%	33%
	S&P/TSX Comp Beta	0.178	0.477*	0.461*	-0.017	0.014
	(t-stat)	(0.150)	(2.503)	(2.117)	(-0.188)	(0.308)
	% of significant obs	80%	40%	40%	0%	0%
	USD/CAD Beta	-0.155	0.157	0.582**	0.789**	0.650***
	(t-stat)	(-2.034)	(-0.859)	(-3.089)	(-0.941)	(-4.244)
	% of significant obs	40%	20%	40%	83%	33%

1991 - 2000	# of Obs Avg turnover ratio	17 0	17 0.1	17 0.3	18 1	18 6.8
	S&P Index Beta	-0.110	-0.028	-0.007	-0.041	-0.013
	(t-stat)	(-0.138)	(-0.383)	(-0.146)	(-0.387)	(-0.085)
	% of significant obs	29%	41%	41%	33%	33%
	S&P/TSX Comp Beta	0.023	-0.011	0.0097	0.185	-0.048
	(t-stat)	(0.4308)	(-0.103)	(0.157)	(1.153)	(-0.471)
	% of significant obs	35%	41%	47%	28%	11%
	USD/CAD Beta	0.604***	0.505***	0.645**	0.932	0.248**
	(t-stat)	(-6.712)	(-3.049)	(-2.551)	(-0.229)	(-2.731)
	% of significant obs	71%	65%	65%	50%	39%
2001 - 2013	# of Obs Avg turnover ratio	14 0.1	14 0.4	14 0.7	14 1.2	14 10.9
	S&P Index Beta	0.006	-0.097	-0.031	-0.042	-0.012
	(t-stat)	(0.043)	(-1.45)	(-0.530)	(-0.610)	(-0.086)
	% of significant obs	29%	21%	7%	36%	57%
	S&P/TSX Comp Beta	0.224**	0.165*	0.185**	0.131*	0.006
	(t-stat)	(2.794)	(2.144)	(2.448)	(1.853)	(0.029)
	% of significant obs	50%	36%	21%	43%	43%
	USD/CAD Beta	0.8469*	0.905	1.002	0.957***	0.791*
	(t-stat)	(-1.791)	(-1.078)	(0.035)	(-0.827)	(-1.848)
	% of significant obs	79%	93%	100%	100%	86%

Table 6: Time-period analysis - Size

The table presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to average turnover ratio as in Table 3 and then also split into one of three groups depending on the year of cross-listing. We examine three time-periods: 1975-1990, 1991-2000 and 2001-2013.
The table presents the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ along with the percentage of significant observations for each group.

The t-statistic is for the test:

H_0: *The average coefficient estimate is not significantly different than zero.*
H_1: *The average coefficient estimate is significantly different than zero.*

		Q1	Q2	Q3	Q4	Q5
1975 - 1990	# of Obs	5	5	5	6	6
	Avg firm size (*millions*)	10	37	93	214	1051
	S&P Index Beta	-0.040	0.038	-0.1175	-0.090	-0.083
	(t-stat)	(-0.1009)	(0.255)	(-1.465)	(-0.735)	(-1.738)
	% of significant obs	40%	20%	40%	50%	33%
	S&P/TSX Comp Beta	0.168	0.469*	0.1801	0.055	0.206*
	(t-stat)	(0.129)	(2.170)	(1.611)	(0.812)	(2.156)
	% of significant obs	60%	0%	40%	0%	50%
	USD/CAD Beta	-0.2995	0.282**	0.8677	0.636	0.546***
	(t-stat)	(-0.958)	(-3.389)	(-0.602)	(-1.538)	(-4.184)
	% of significant obs	40%	0%	40%	50%	83%
1991 - 2000	# of Obs	17	17	17	18	18
	Avg firm size (*millions*)	40	104	254	564	3953
	S&P Index Beta	-0.050	0.077	-0.021	-0.049	-0.091**
	(t-stat)	(-0.281)	(0.803)	(-0.293)	(-0.753)	(-2.733)
	% of significant obs	41%	24%	35%	33%	44%
	S&P/TSX Comp Beta	-0.039	-0.063	0.0201	0.279*	0.113***

	(t-stat)	(-0.244)	(-0.830)	(0.215)	(2.092)	(3.215)
	% of significant obs	24%	12%	35%	44%	44%
	USD/CAD Beta	-0.148***	0.574**	0.8851	0.754	0.720***
	(t-stat)	(-3.438)	(-2.875)	(-0.893)	(-1.105)	(-6.155)
	% of significant obs	24%	29%	76%	61%	94%
2001 - 2013	# of Obs	14	14	14	14	14
	Avg firm size (*millions*)	74	165	381	872	5921
	S&P Index Beta	-0.189	0.023	-0.036	0.148	-0.129
	(t-stat)	(-1.606)	(0.273)	(-0.662)	(1.084)	(-1.651)
	% of significant obs	21%	29%	36%	29%	36%
	S&P/TSX Comp Beta	0.383**	0.093	0.053	-0.070	0.253**
	(t-stat)	(2.639)	(1.196)	(1.365)	(-0.432)	(2.997)
	% of significant obs	29%	21%	21%	50%	71%
	USD/CAD Beta	0.763*	0.960	0.812**	0.977	0.990
	(t-stat)	(-1.814)	(-0.697)	(-2.697)	(0.440)	(-0.165)
	% of significant obs	71%	100%	100%	86%	100%

Table 7: Business cycle analysis

The table presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is spit according the state of the business cycle in the United States at the time of cross-listing (determined by the National Bureau of Economic Research).
The table presents the cumulative and average $\beta_{S\&P}$, δ_{TSX}, $\gamma_{curr} USD/CAD_t$ along with the percentage of significant observations for each group.

	SPX				**TSX**				**USDCAD**				
	Cum. Beta	**# Sig. Obs.**	**Avg Beta**	**% Sig. Obs.**	**Cum. Beta**	**# Sig. Obs.**	**Avg Beta**	**% Sig. Obs.**	**Cum. Beta**	**# Sig. Obs.**	**Avg Beta**	**% Sig. Obs.**	**Total Obs.**
Expansion	-4.637	58	-0.026	33.0%	17.394	56	0.099	31.8%	114.096	119	0.648	67.6%	176
Contraction	-1.323	4	-0.165	50.0%	2.787	7	0.348	87.5%	7.036	7	0.879	87.5%	8

Figure 1: Comparison of average coefficient estimates across quintiles

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to average turnover ratio as measured by:

$$Turnover_{US/CN} = \frac{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{Avg\ Market\ Cap}}{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}{Avg\ Market\ Cap}} = \frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}$$

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

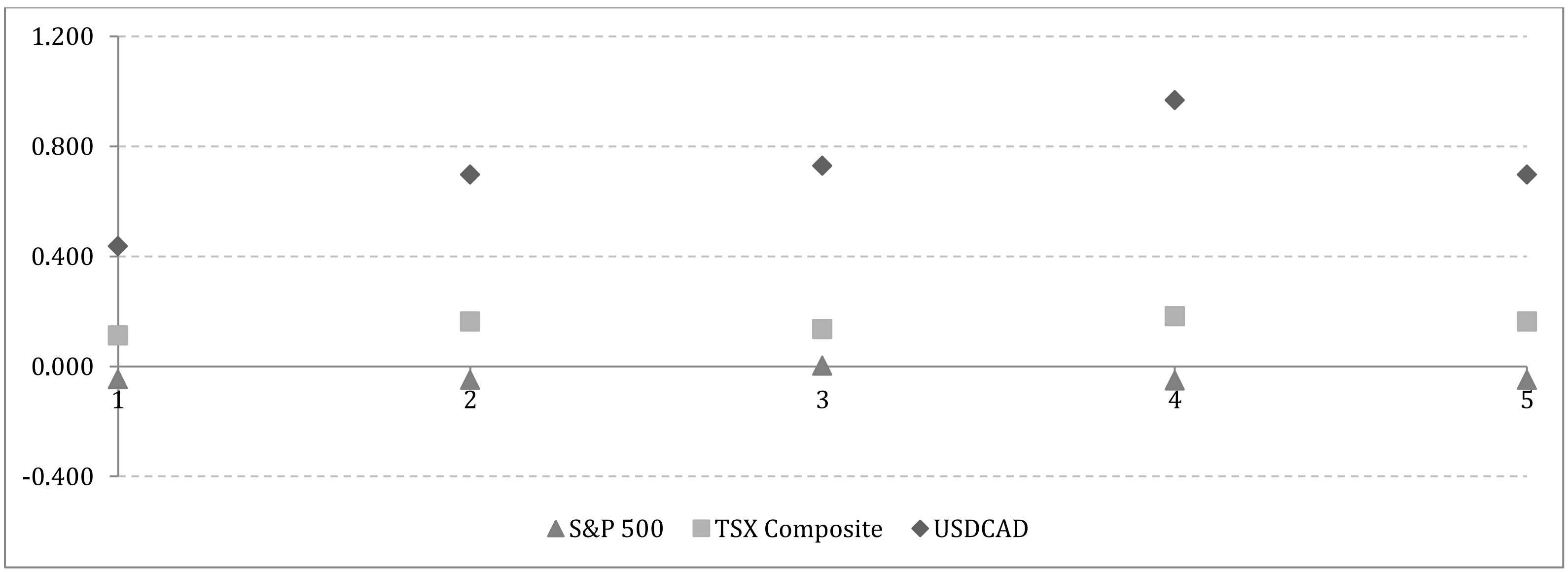

Figure 2: Comparison of average coefficient estimates across size quintiles

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to firm size as measured by market capitalization

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

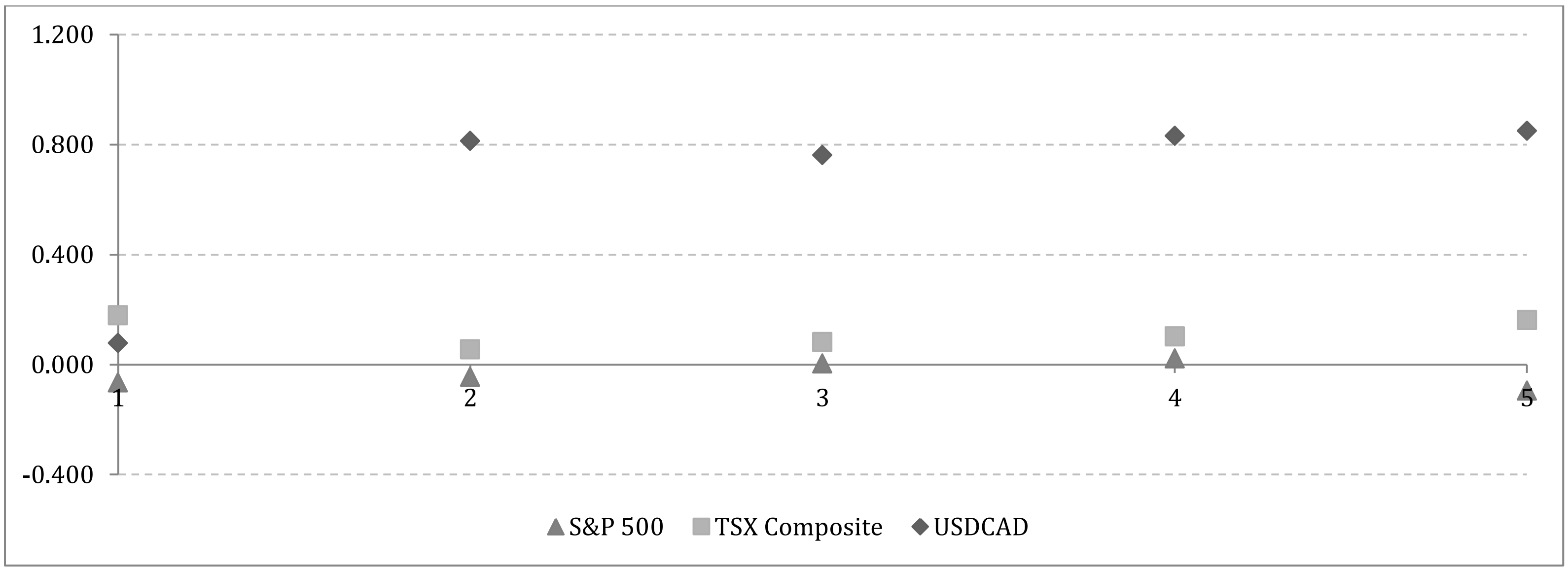

Figure 3: Comparison of average coefficient estimates across quintiles (1975 – 1990)

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

for the companies that cross-listed during the period 1975 to 1990.

The above model is estimated for each stock using daily trading data. The sample is split into quintiles according to average turnover ratio as measured by:

$$Turnover_{US/CN} = \frac{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{Avg\ Market\ Cap}}{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}{Avg\ Market\ Cap}} = \frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}$$

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

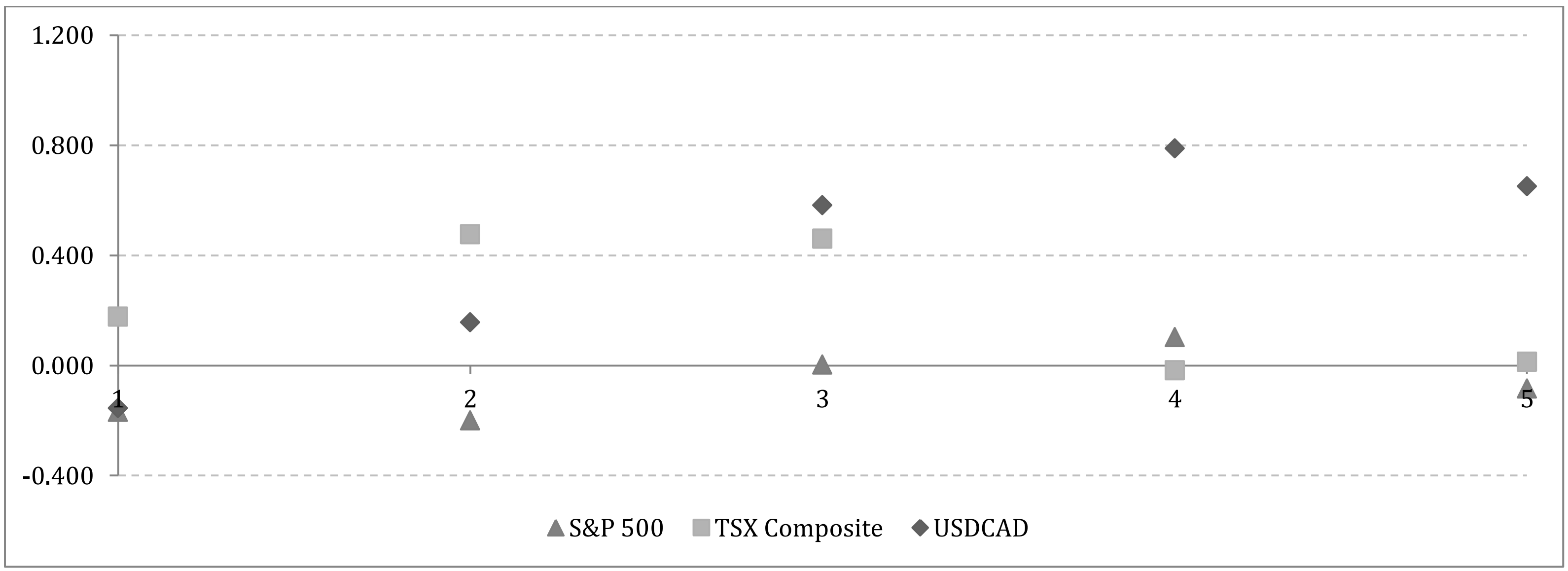

Figure 4: Comparison of average coefficient estimates across quintiles (1991 – 2000)

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

for the companies that cross-listed during the period 1991 to 2000.

The above model is estimated for each stock using daily trading data. The sample is split into quintiles according to average turnover ratio as measured by:

$$Turnover_{US/CN} = \frac{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{Avg\ Market\ Cap}}{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}{Avg\ Market\ Cap}} = \frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}$$

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

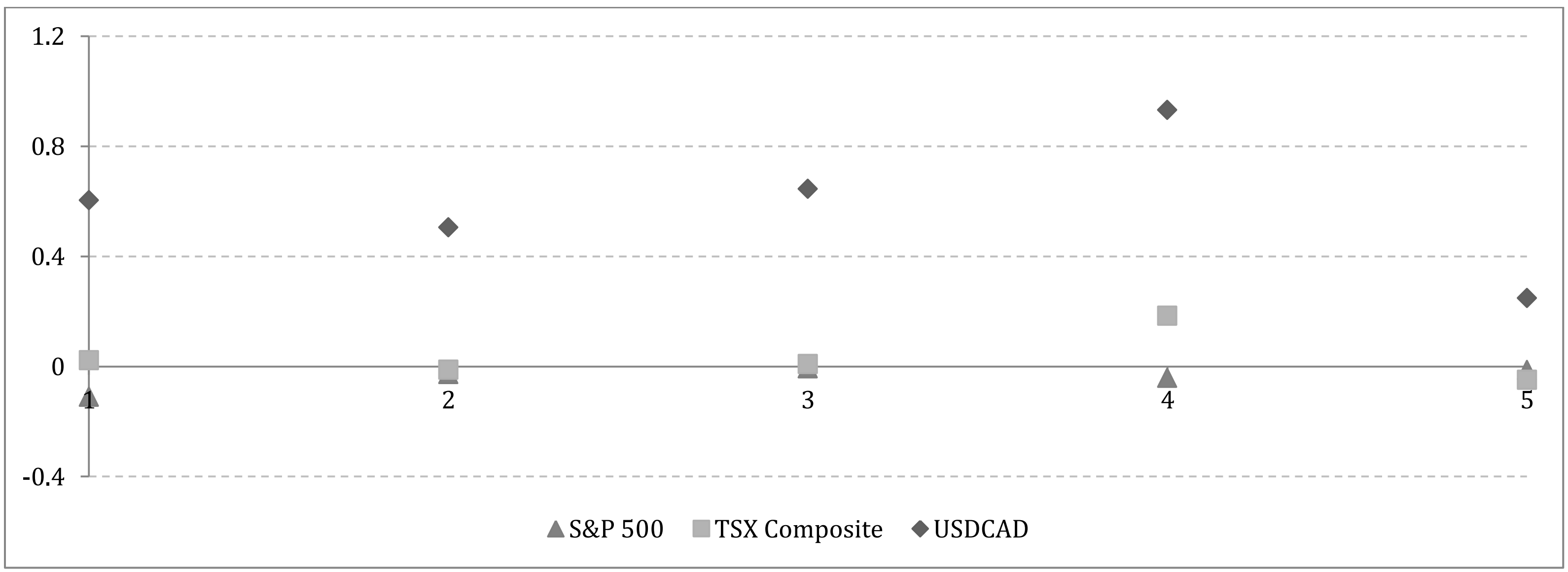

Figure 5: Comparison of average coefficient estimates across quintiles (2001 – 2013)

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

for the companies that cross-listed during the period 2001 to 2013.

The above model is estimated for each stock using daily trading data. The sample is split into quintiles according to average turnover ratio as measured by:

$$Turnover_{US/CN} = \frac{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{Avg\ Market\ Cap}}{\frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}{Avg\ Market\ Cap}} = \frac{\sum_{t=1}^{365} Daily\ Shares\ Traded_{US,t}}{\sum_{t=1}^{365} Daily\ Shares\ Traded_{CN,t}}$$

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

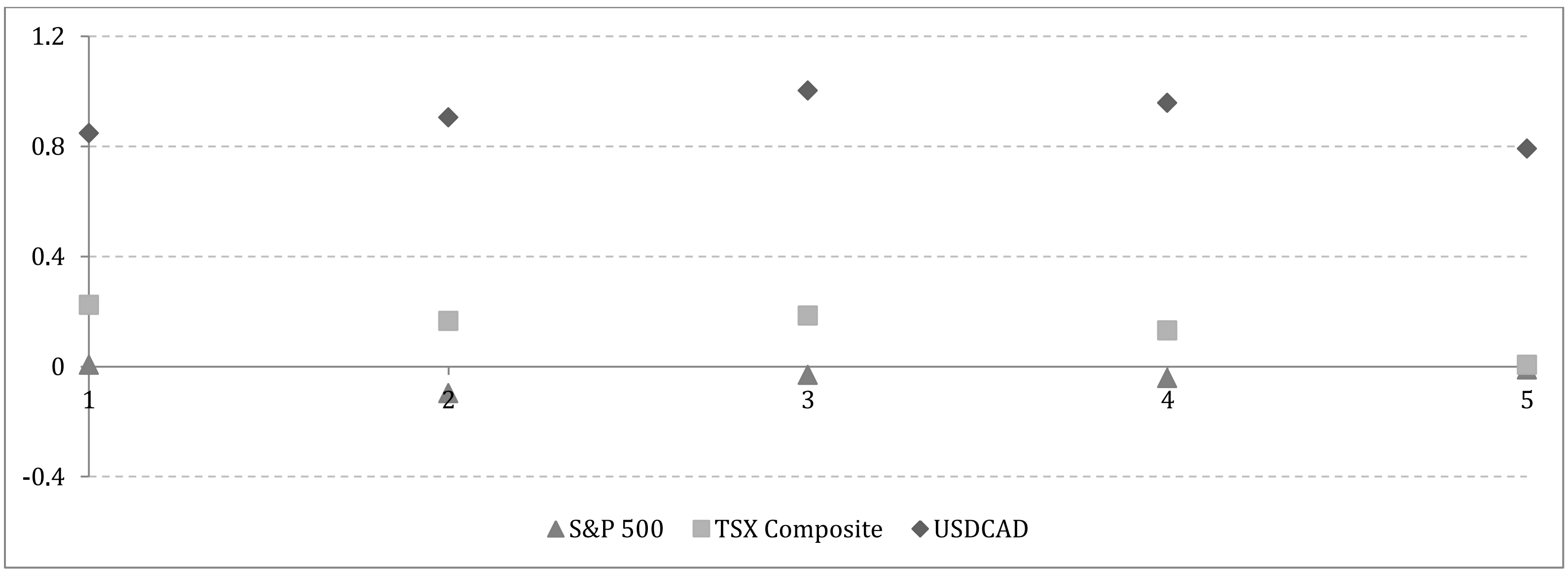

Figure 6: Comparison of average coefficient estimates across size quintiles (1975 - 1990)

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to firm size as measured by market capitalization

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

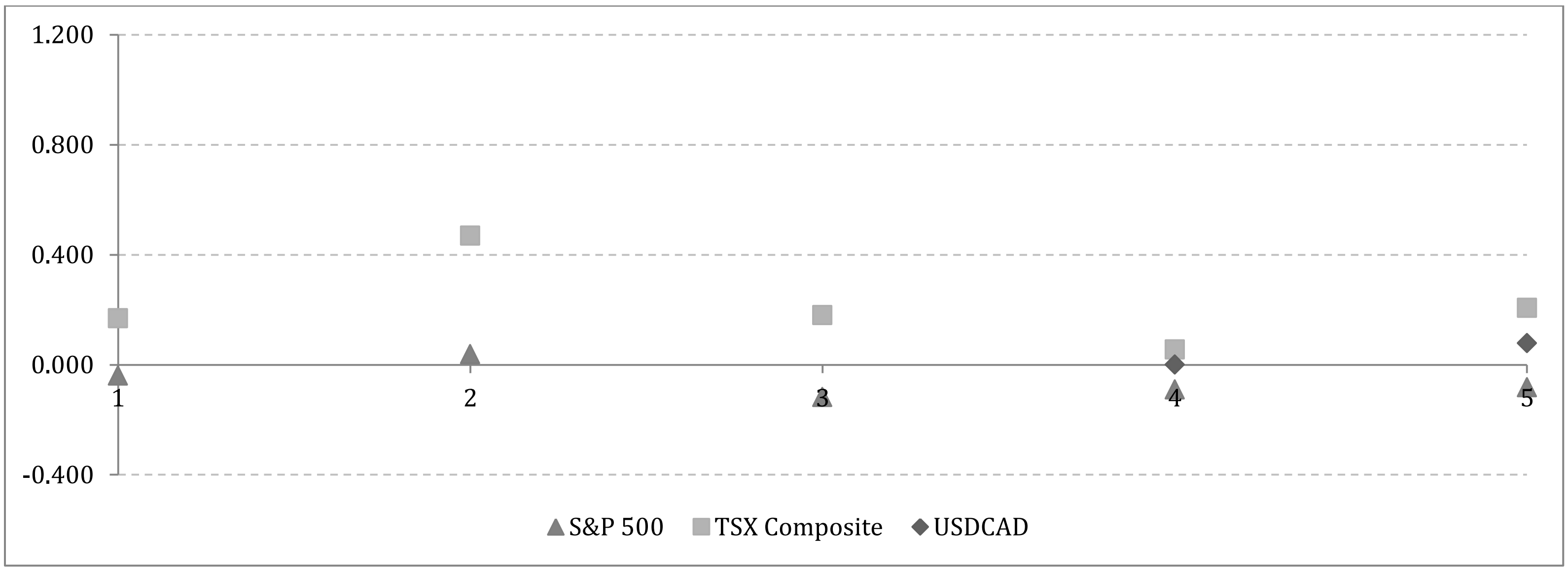

Figure 7: Comparison of average coefficient estimates across size quintiles (1991 - 2000)

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to firm size as measured by market capitalization

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.

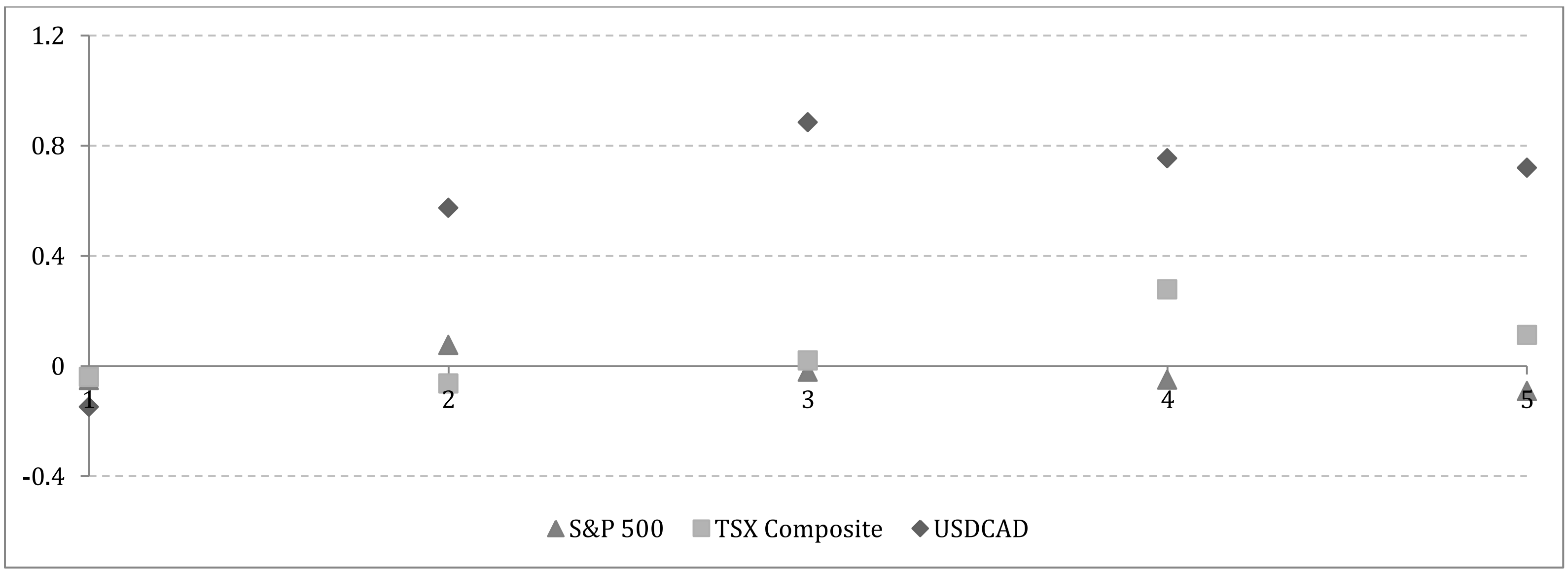

Figure 8: Comparison of average coefficient estimates across size quintiles (2001 – 2013)

The figure presents the results from:

$$r_{a-b,t} = \alpha + \beta_{S\&P} S\&P_t + \delta_{TSX} TSX_t + \gamma_{curr} USD/CAD_t$$

The above model is estimated for each stock (total 184) using daily trading data. The sample is split into quintiles according to firm size as measured by market capitalization

The figure plots the average $\beta_{S\&P}$ average, δ_{TSX} and average $\gamma_{curr} USD/CAD_t$ for each quintile.