Price Discovery in US-Canadian Cross-listed Shares

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Abstract

Given the increasing integration of markets around the world, concerns have been expressed about the survival of smaller national exchanges in competition with larger, more liquid exchanges. Several theories have been put forward regarding the likely long-term survival of smaller exchanges, but little actual empirical evidence has been presented to suggest which of the theories, if any, are correct. We explore this issue within the setting of Canadian and US firms cross-listing onto each other's exchanges using the component share measure of each exchanges contribution to price discovery. We look at Gonzalo and Granger (1995) component shares over a 14 year period from 1996-2009 and find that each market is on average informationally dominant for its own companies, with the exception of Canadian firms listing on the NASDAQ. We also find that there is considerable time variation in the component shares, but little evidence that the Canadian market is systematically losing competitiveness to the US exchanges as has been feared. We also find that known determinants of the level of price discovery appear unrelated to the changes in price discovery.

Introduction

In the past investors were largely restricted, based on the speed of information and national rules, to trading within their own country, or even more locally. As a result of globalization and technology we have seen information and regulatory barriers to international investment decrease, and as a result there has been a marked increase in competition between exchanges. In particular, exchanges are competing for international investors, who increase the liquidity and activity on an exchange, and for cross-listings. The process of competition has resulted in efforts being made to lower transaction costs, improve efficiency and promote economic growth (Steil, 2002). A very visible effect of the competition has been the merger of national exchanges into ever increasing exchange groups such as the NYSE Euronext or the NASDAQ OMX.

The creation of such large exchange groups spanning continents and time zones however has raised questions about the long term survivability of smaller exchanges. These smaller exchanges lack the efficiencies of larger exchanges and risk losing local companies to larger exchanges in an effort to improve liquidity and prices for their securities (*PR Newswire, 1988)*. Several competing theories have been proposed for the future of smaller national exchanges, ranging from predictions of their eventual demise (Carpentier et al., 2008) to a dramatic reduction in their numbers with the survivors taking specialized roles (Coffee, 2002). However, empirical evidence on the effects of competition on exchanges, and the idea that some exchanges are clearly losing, is limited and in some cases contradictory.

In this paper we explore the competitiveness of a smaller national exchange in competition with larger exchange groups. In particular, we look at the competition between the Toronto Stock Exchange (TSX) and the three main US exchanges the NYSE, NASDAQ and AMEX. Competition between the Canadian and US exchanges offers a good opportunity to look at issues around the survivability of smaller exchanges due to the highly integrated nature of the two markets, which makes it very easy to list and also allows investors easy access to other countries exchanges. We evaluate the impact on the two exchanges by looking at relative contributions of the various exchanges to the price discovery of cross listed stocks. We identify not only Toronto Stock Exchange listed companies that are cross-listed in the US but also US listed firms cross-listed on the TSX for a 14 year period from 1996 to 2009. We start

at 1996 as this is the earliest period for which we can get intra-day data. For each year we calculate Gonzalo and Granger (1995) component shares to measure the relative contribution of each exchange to the price discovery process. This will allow us to examine how the contributions to price discovery of the Canadian and US exchanges have evolved over the sample period, and to shed some light on the future prospects of smaller exchanges in light of the dire predictions of Carpentier et al. (2002) and others.

Our findings show little evidence that the Toronto Stock Exchange is systematically losing ground to the US exchanges, either in relation to price discovery or trading and liquidity measures. We do however find that there is time variation in the contributions to price discovery of the various exchanges. Specifically, we find that the home exchange dominates price discovery, but for Canadian companies the overall average Canadian component share reaches a low point in 2006 at which point the US is slightly dominant. However, particularly during crisis periods we see that price discovery migrates to the Canadian exchange, particularly during the Global Financial Crisis (GFC). The patterns also differ depending on the exchange firms are listing to or from. In particular we find that the AMEX exchange has lost competitiveness to the TSX fairly consistently over the sample period. We also find only mixed evidence that the change in component shares are related to changes in trading and liquidity measures, in particular relative spreads, trading and quoting activity and volume traded. Overall the results appear to support the findings of Harris et al. (2002) that the competitive position of exchanges will ebb and flow as they compete.

The rest of the paper is organized as follows. Section 2 discusses the relevant literature on the survival of small exchanges and price discovery. Sections 3 and 4 outline the methodology and the data employed respectively, along with giving some summary statistics on cross-listings between the two countries. Section 5 presents the results and Section 6 concludes the paper.

1. **Literature Review**

2.1 Exchange Competition

Several theories have been expressed regarding the likely future for small national exchanges in competition with larger exchanges. Carpentier et al. (2008), Gaa et al. (2001) and DiNoia

(2001) all speculate that what could arise from this consolidation process is the creation of a single super-exchange, spanning the globe and allowing for 24/7 trading. In the process, they argue that this super-exchange would dominant and eventually strip national exchanges of the most liquid and attractive firms leaving only the illiquid and small and in the process the exchanges attraction to investors. One concern expressed in these studies is the effect that the loss of a strong national exchange would have on the economic development of countries. In particular the loss of national exchanges could reduce the access to capital for small to medium sized companies who would be too illiquid to appeal to global investors (Carpentier et al., 2002; Ferrarini, 2002) and local exchanges would likely be too illiquid to service the needs of these firms. In addition weak local exchanges would reduce the economic development of the country (Marano, 2000) and reduce the domestic financial services industry with the resulting loss of expertise and high skilled employment (Carpentier et al. 2002).

Coffee (2002) offers a different vision, suggesting that we will see the development of a small number of large exchanges. However, he also argues that rather than disappear, smaller exchanges will find niches within which to specialize. One example Coffee gives is in disclosure requirements, where other exchanges will be able to offer differing disclosure regimes that cater to the demands of firms. Disclosure requirements are one way that exchanges could specialize, or markets could seek to adjust listing rules to different industry needs in much the way that the NASDAQ developed as a high tech industry exchange.

One study that offers some empirical evidence is Harris et al. (2002) who explores the relative price discovery contributions of the NYSE against regional US exchanges. The study observes that there was a competitive process resulting in an ebb and flow effect whereby, at some points in the time the contribution of the NYSE strengthened while in others it waned. The changes appeared to be related to efforts made by the different exchanges to attract liquidity and reduce transaction costs. Of note is the fact that despite being at a disadvantage against the NYSE, the regional exchanges were able to attract a greater share of price discovery in the middle time period (1992), suggesting they were able to compete. This raises the prospect that smaller exchanges need not become pure satellite markets for larger exchanges.

The survivability of smaller national exchanges has been of particular concern to commentators in Canada, especially around the Toronto Stock Exchange (TSX) and its competitive position against the larger US based exchanges like the NYSE and NASDAQ. The US and Canada have over a period of decades have undergone considerable integration, such that Canadian firms have easier access to US capital markets than those from other countries . As a result, substantial numbers of Canadian firms have cross-listed onto US security exchanges, around 2000 in 2006 (Carpentier et al. 2002), making them the largest group of foreign listings. In addition, cross-border transactions for investors should be relatively easy as well, allowing Canadian investors to seek the lowest cost market in which to trade. This level of integration between the US and Canadian markets offers an excellent opportunity to evaluate how other markets will fare around the world given the continuing trend towards market integration (de Brouwer, 2003).

While significant concerns have been raised about the long-term competitiveness of the Canadian exchanges, the empirical evidence is mixed. Reguly (1999), for instance, argues that the liquidity on the TSX had dropped considerably and that the exchange was being hollowed out by Canadian companies listing in the US. Hendry and King (2004) also observe that 15% of TSX-listed firms have a cross-listing on a US exchange, and that trading on the US exchange accounts for nearly half the trading volume. However, Jenkinson and Ljungqvist (2001) and Boisevert and Gaa (2002) note that up until around the early 2000's the Canadian exchanges had enjoyed greater increases in exchange listings than many other exchanges, including the US. In addition the value of trading had increased 300% in a 5 year period (Boisevert and Gaa, 2002). It is far from clear, therefore, that the number of cross-listings and the level of US trading activity are having a detrimental effect on the TSX, or that its long term survival is threatened despite the supposition of Carpentier et al. (2008) and others.

2.2 Price Discovery

Part of the difficulty in evaluating the effects of exchange competition and determining the relative importance of exchanges encompasses a number of facets including liquidity, spreads and information dissemination and creation. However, component shares and information shares, which break down the relative contributions to price discovery of various markets, offer one way of evaluating these factors. Price discovery or the search for an equilibrium price is a key function of an exchange (Eun and Sabherwal, 2003). Effectively, price

discovery is the process by which new information is impounded into prices. Bacidore and Sofianos (2002) argue that price discovery should largely occur in the home market, as this is the market in which information about the company is mostly created. However, this assumes investors will trade on that information in the home market, whereas investors in highly integrated markets have the ability to choose the cheapest trading venue when it comes to impounding information into prices. If this is the case, then it is likely the cheaper market will become the informationally more important market with prices in other markets adjusting to the cheap market prices. As a result, a cheaper and more liquid foreign market could also become the informationally dominant market making the home exchange largely irrelevant. The location of price discovery is also a concern for the exchanges themselves, with the Board of Governors of the TSX stating "the TSE cannot afford to have the US markets become the price discovery mechanism for Canadian interlisted stocks". Price discovery therefore offers a measure by which the relative competitiveness and relevance of markets can be established and evaluated.

There is a growing literature examining price discovery in a number of settings, particularly in looking at the price discovery of stocks listed on multiple exchanges. Initially, papers looked at the relative importance of exchanges within the US, particularly between the NYSE and regional exchanges (Harris et al., 1995; Hasbrouck, 1995). An interesting extension in Harris et al. (2002) looked at the relative price discovery contribution of the NYSE and regional exchanges at three points in time; 1988, 1992 and 1995. They find that price discovery contributions change over time, particularly in relation to changes in the competitive position of the various exchanges against each other. Specifically, they find that as the NYSE became relatively more expensive with regards to transaction costs in around 1992, price discovery migrated to the regional exchanges. In 1995, once NYSE spreads had reduced, the NYSE regained some of its contribution to price discovery.

A number of studies have also examined the location of price discovery for internationally cross-listed companies, specifically addressing the question of which is the informationally dominant market. Despite the assertions of Bacidore and Sofianos (2002) that the home market should dominate the price discovery, the empirical evidence is mixed. Lieberman et al. (1999) examined the price discovery of 6 Israeli firms cross-listed on the NYSE and found only a limited informational role for 5 of the firms. Su and Chong (2007) looked at eight Chinese firms listed on both the Hong Kong Stock Exchange and the NYSE and also found

only a limited informational role for the US exchange. Likewise Ding et al. (1999), who looked at Malaysian companies listed on the Singapore Exchange, Lok and Kalev (2006) and Frijns et al. (2010), who both study bi-directional listings between the Australian and New Zealand Stock Exchanges, find the home market dominates but that the foreign market has a small but significant role in price discovery.

In contrast, Pascual et al. (2006) finds the NYSE has no role in price discovery for Spanish stocks, while Grammig et al. (2005) reaches the same conclusion with regards to German stocks listed on the NYSE. Effectively, in these markets the NYSE plays no informational role at all and is purely a satellite exchange. However, several studies have found that the foreign market plays a very important role in price discovery. Kadapakkam et al. (2003) in a study of Indian companies listed on the London Stock Exchange finds both markets contribute equally to price discovery. Meanwhile, Hupperts and Menkveld (2002) looking at Dutch firms cross-listed on the NYSE find wide variations on a per company basis, with some stocks dominated by the home market, some by the foreign market and others by both.

Eun and Sabherwal (2003) examined price discovery for Toronto Stock Exchange stocks cross-listed on US exchanges for a six-month period in 1998 using Gonzalo and Granger (1995) component shares. As with the findings in Hupperts and Menkveld (2002), Eun and Sabherwal (2003) show wide variation in the contribution to price discovery of the US exchanges, averaging 38.1% but ranging from .2% to 98.2%. They also note that while the home exchange dominates in many cases, there are a number of companies whose price discovery is dominated by the US exchange, making the TSX a mere satellite exchange. The study then goes on to try and identify the determinants of price discovery, finding that price discovery is driven by the proportion of information trades occurring in the US. Lieberman et al. (1999) and Hasbrouck (1995) also show that the bid-ask spread ratio affects the level of price discovery.

One weakness of the studies to date on price discovery, particularly in relation to measuring the effects of exchange competition on the future of smaller exchanges, is that most of the studies are snapshots in time, focusing on measuring price discovery in one relatively short period of time, typically less than a year. As such, changes over time in price discovery, and what may cause these shifts, have not really been examined in the literature. One study that did look at the development of price discovery over time was Frijns et al. (2010). The paper

examines both New Zealand companies listed on the Australian Stock Exchange and Australian firms listed on the New Zealand Exchange for the period between 2002-2007. The authors show that while the home market was dominant for both New Zealand companies listed in Australia the Australian companies listed in New Zealand, the Australian exchange was increasing its share of price discovery over time for both groups. This suggests that the New Zealand exchange is increasingly becoming a pure satellite market of Australia with information impounded in the Australian prices, albeit at a gradual pace.

3. Methodology

To study the informational role of the US and Canadian markets for US-Canadian cross-listed stocks we investigate the contribution to price discovery of both markets.

Consider a single security that lists in 2 different countries (US and Canada). Let p_t^{US} be the (log) price of the asset traded in the US market and expressed in US dollar. Similarly, let p_t^{CAN} be the (log) price of the asset traded in the Canadian market expressed in US dollar. If the two assets are identical and completely fungible, then arbitrage implies that the price difference $(p_t^{US} - p_t^{CAN})$ is bounded with probability 1. Stated differently, if the prices ($p_t = (p_t^{US} \quad p_t^{CAN})'$) in the US and Canadian market are for the same asset then prices will be cointegrated with cointegrating vector $\beta' = (1 \quad -1)$. Cointegration in the prices of these assets implies that price changes can be expressed as an error correction model of the form

$$\Delta p_t = c + \alpha \beta' p_t + \sum_{q=1}^{Q} \Gamma_q \Delta p_{t-q} + \varepsilon_t, \tag{1}$$

where α is the (2 × 1) vector of containing the speed of adjustment coefficients for US prices and Canadian prices and Γ_q are (2 × 2) matrices containing coefficients on lagged prices. Note that the specification of the cointegrating vector β', implies that we expect the first element of α, $\alpha^{US} \leq 0$ and the second element of α, $\alpha^{CAN} \geq 0$.

We obtain our price discovery measure from the VECM stated in Equation (1) by following the permanent-transitory (PT) decomposition of Gonzalo and Granger (1995).[1]

The first price discovery measure is based on the estimates from Equation (1) and is used by Eun and Sabherwal (2003) in their study on price discovery among US-Canadian cross-listed stocks and compares the speed of adjustment coefficients of the two markets. The lower the speed of adjustment coefficient, the more informative that market can be assumed to be. For example, if the US market is completely dominant and the Canadian market is a pure satellite market, then we expect $\alpha^{US} = 0$ and $\alpha^{CAN} > 0$. Vice versa, if the Canadian market is completely dominant and the US market is a pure satellite, then we expect $|\alpha^{US}| > 0$ and $\alpha^{CAN} = 0$. If neither market is completely dominant $|\alpha^{US}|$ and α^{CAN} will both be positive, but their relative magnitudes will give us an indication of the degree of dominance over the other market. Based on Eun and Sabherwal (2003) we therefore define the following measure for price discovery,

$$PD^{US} = 1 - \frac{\left|\alpha^{US}\right|}{\left|\alpha^{US}\right| + \alpha^{CAN}}, \qquad (2)$$

4. Data

We obtain data on all Canadian TSX-listed firms that are (or have been) cross-listed on one of the three main US markets: NYSE, AMEX and Nasdaq. For these firms, we collect intraday data from the Thompson Reuter Tick History database (TRTH) maintained by SIRCA for the period 1996-2009, a sample period of 14 years.[2] This data contains all trades and quotes (plus associated volumes) time stamped to the nearest thousandth of a second. We follow Grammig et al. (2005) and use the midpoints of quotes to study price discovery, as these are free from the bid-ask bounce that is normally observed in transaction prices. Subsequently, we convert all our prices into US dollars and sample our data at a one-minute frequency.

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[1] An alternative would be to use the Information Shares defined by Hasbrouck (1995)
[2] Securities Industry Research Centre of Asia-Pacific.

We use this data to compute price discovery measures for each stock in each year. However, before proceeding with the estimation of the error correction model we take several steps to filter the data. First, we exclude those cross-listings that have less than 40 days of quoting activity in both markets in a given year. This filter is applied to ensure that price discovery measures are representative for that given year. Second, we perform augmented Dickey-Fuller (1981) (ADF) unit root tests for each stock and for each year. The concept of cointegration only becomes relevant when the time-series of stock prices in both markets are non-stationarity. Non-stationarity of the time-series is therefore a requirement for our cointegration analysis and we exclude any stocks for which the ADF test rejects the presence of a unit root (at the 5% level). Third, we perform the Johansen (1995) test for cointegration, where we test for the presence of no cointegrating relationships versus one cointegrating relationship and remove those firms in the years where the Johansen test does not reject the null of no cointegrating relationship. After cleaning the data in this way, we are left with 1,381 firm year observations.

In Table 1 we provide an overview of the number of cross-listings per year and per exchange. The sample starts with 43 cross-listed firms in 1996, grows to a maximum of 132 cross-listings in total in 2007 before declining again to 121 cross-listings in 2009. However, the increase in cross-listings has not been uniform when we split the sample by the exchange on which the listing takes place. In the early parts of the sample period, most cross-listing occurred on the NYSE. However, during the period of the dot-com bubble, cross-listings on the Nasdaq grew considerably, with the Nasdaq having the most cross-listings in 2001.[3] The Amex received little attention from cross-listed firms up to 2004, when this market saw a considerable increase in the number of cross-listings from Canadian firms. By the end of our sample period, 2009, most of the cross-listings in our sample are on the AMEX.

< Insert Table 1 Here >

Table 1 also provides an overview of the cross-listing numbers for US companies listing on the Toronto Stock Exchange. In contrast to large numbers of Canadian firms listing in the

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[3]This provides some evidence of the "market bubble explanation" as described by Coffee (2002). This explanation argues firms have cross-listed in the US markets to benefit from the overvaluation that occurred during the bubble. Since this bubble occurred most prominently among Tech-stocks, it is not surprising to see cross-listings increase on the Nasdaq.

US, US companies listing on the TSX are considerably less common with just 20 in our sample at its peak. Further, we also do not see a considerable increase in the number of US firms cross-listings over the sample period. In 1996 there were just 7 US cross-listed companies, which grew to 12 in 1998 and remained around that level until a marked increase in 2007 when the number surged to 19. When we split the sample by exchange we again see differences over time in the originating exchange. The number of companies from the NYSE remains relatively stable over the sample period, with a decline in 2007 onwards. The NASDAQ is also relatively stable over time with small peaks in 1999 and 2007. For most of the sample period we see very few firms cross-list to the TSX from the AMEX, however, in 2007 we see a significant jump in the number of companies, from 2 to 9 then to 11 in 2008. The jump in AMEX listings onto the TSX seem to be solely driving the increase in overall US companies cross-listing onto the Toronto exchange.

5. Results

To assess the level of price discovery for the cross-listed companies on the US and Canadian markets, we estimate the VECM on a yearly basis following the Johansen procedure, i.e. by estimating the auxiliary regressions and computing the canonical correlations. This provides us with Full Information Maximum Likelihood estimates for the coefficients in the VECM and also provides us with a direct way to compute the Component Shares, as the PT decomposition of Granger and Gonzallo (1995) follows directly from the canonical correlations.

In Panel A of Table 2, we report the component shares of the Canadian market for Canadian firms cross-listed on the US markets. Panel A shows the overall component share and the Component Share per exchange. Overall, we see that the component shares are highest for the Canadian market at a value of about 57%. However, the Canadian market obviously does not dominate for all shares. The standard deviation of component shares is large at 22% and the range of component shares is very wide, with the minimum share at 2.7% and the maximum share at 99.4%. Our range in the component shares are similar to those observed in Eun and Sabherwal (2003). Component shares also seem to differ across the three US exchanges. The

NYSE and Amex are quite comparable with mean Canadian component shares of 63% and 66% respectively. For cross-listings on the NASDAQ, the Canadian component shares are lower at an average of about 44%. Hence for Nasdaq cross-listings, the US market seems to be more important in terms of price discovery.

< Insert Table 2 Here >

In Panel B of Table 2 we present the Canadian component shares for US firms cross-listed on the Toronto Stock Exchange. On average we see that the US exchanges dominate the Canadian market for price discovery with an average firm year component share of 38%. However, we observe very wide ranges with some firms dominated by the home market (1.2% component share) while for others the US market is a satellite market with most of the price discovery occurring in Canada (92% component share). We also observe some interesting patterns when we separate the firms by their home exchange. Average NYSE firms component shares are very similar to the full sample average, although they do have slightly less variation. Firms cross-listing from the NASDAQ, as with Canadian firms cross-listing onto the NASDAQ, have a lower average component share indicating less of the price discovery occurs on the TSX for these firms. Given the industry specific nature of the firms on the NASDAQ, predominantly pharmaceutical and software based firms, this may suggest that the NASDAQ holds a competitive advantage in price discovery for these types of firms. In contrast to the two other exchanges however, the TSX dominates the AMEX for price discovery. On average 56% of price discovery occurs on the Canadian market. This is contrary to expectations as the US is both the home market, so should create most of the information, and is a larger and more liquid exchange than the TSX. Prevailing theories would predict that the US dominates, yet we observe that it is Canada that is dominant. Again, given the highly clustered nature of the firms listing to and from the AMEX it maybe that the TSX has a competitive advantage for resource based stocks.

< Insert Figure 1 Here >

With a few exceptions, Canadian firms listing on the NASDAQ and AMEX firms listing on the TSX, we observe that on average the home market dominates the price discovery process. This is broadly in line with much of the literature which finds that home market is the

informationally important market. However, we also find that in all cases the foreign market has a significant albeit lesser role. The wide ranges also suggest that, while on average the home market dominates, for some companies the opposite is true. The findings are supportive of the earlier findings by Eun and Sabherwal (2003) on Canadian companies cross listing in the US.

In Panel C of Table 2, we show the evolution of the Component Shares over time for both firms listing from and to the Canadian markets, for the full sample and when separated by the different exchanges. The first column shows the average Component Shares for all Canadian-US cross-listings per year. Overall, there has been some time variation in the Component Shares, which start at a value of about 56% in 1996. Canadian Component Shares peak around the time when the dot com bubble burst and then again in 2002, before they decline, reaching a their low in 2006, indicating that the US exchanges were becoming increasingly informationally dominant over this period. However, during 2007 and 2008 we see a marked increase in price discovery in the Canadian market at the expense of the US exchanges and wind up with Canada having a greater share of price discovery than in 1996.

< Insert Figure 2 Here >

When we look at the exchange specific averages in columns 2-4 of Table 2 and Figure 2 we also see considerable time variation. Both the NYSE and NASDAQ display a similar pattern over time in the component shares. Both exchanges have somewhat stable component shares until the 2000-2002 period were we see the Canadian component shares increase. From 2002 until 2006-2007 there is a decrease of around 23% in the component shares, indicating that the NYSE and NASDAQ were increasing their share of price discovery at the expense of the TSX. In the period since 2007 however the shares have changed dramatically with a marked switch back to Canada for price discovery. In both cases component shares in 2009 are at roughly the same level as the late 1990's. For Canadian companies listing on the AMEX we see a very different pattern, namely the Canadian component shares increase almost every year. The decreasing contribution of the AMEX suggests that this exchange is becoming increasingly less important for Canadian companies, despite the large numbers listed on this exchange at the end of the sample period.

< Insert Figure 3 Here >

The patterns for US companies cross-listing to the Toronto Stock Exchange are different in some respects, although again they show considerable time variation in Figure 3. With the Canadian firms we saw an impact around the time of the dot-com bubble which resulted in Canadian component shares increasing. However, for US firms we see little evidence of the dot-com bubble in either the total sample or for the NASDAQ firms. In general the patterns are less clear for the US firms, most likely a result of the greatly reduced number of observations per year which mean additions and removals to the sample may have a noticeable impact. For the total sample we see a decline in component shares until around 2002, by which stage the share of price discovery for the Canadian market has nearly halved. Between 2002 and 2006 component shares are roughly stable with several spikes. However, as with the Canadian cross-listings to the US, from 2007 we see a dramatic increase in the Canadian component share of the US firms, a doubling in just four years to 51.1%. This pattern is roughly the same for both firms from the NYSE and the NASDAQ.

The patterns in the price discovery offer some interesting insights into the nature of the competition between exchanges and potential future developments. Carpentier et al. (2007) argued that the Canadian market was in a losing fight with the US exchanges and was likely to eventually be dominated by them. Their concern was what they saw as an inevitable process where one dominant market would arise and squeeze out smaller exchanges like the TSX. However, as shown by the component shares, what we observe is more in line with what Harris et al. (2002) finds, namely an ebb and flow in price discovery as markets gain or lose competitiveness over time. For Canadian firms in particular we see marked retreats back home for price discovery in the 2000-2002 period and around the GFC. Further, the argument that the Toronto exchange is bound to lose also appears premature. The TSX appears to be dominating the AMEX market for both Canadian firms and for US firms. This maybe a result of the nature of the companies, which are clustered in resource based areas. If so, this would suggest that the arguments of Coffee (2002) who argues that exchanges will not necessarily disappear but will instead specialize may well be accurate.

Liquidity and Trading Measures

In Table 3 we show several measures of liquidity and trading activity over time. Price discovery should be driven, at least in part, by factors like spreads and liquidity. In highly integrated markets investors have a choice of trading location, either their home market or the foreign market. In theory at least, investors will prefer to trade in the cheaper and more liquid market. As such, even trading based on information created in the home market maybe impounded into the foreign prices first. Therefore, changes in the relative trading activity between the two markets, and the relative cost of trading may provide insights into the nature of the competition between exchanges.

< Insert Table 3 Here >

In Panel A of Table 3 we report relative liquidity measures for the Canadian market relative to the US stock market.[4] All relative measures are calculated as the Canadian value divided by the US value. The first column reports the relative percentage spread. Overall, we observe an upward trend in the relative spread up to 2006. An increase in relative spread suggests Canadian spreads have lost competitiveness against the US. However, from 2007 onwards the relative spreads decrease. In the first two columns of Panel B of Table 3, we show the percentage spreads in both markets as a way of seeing whether changes in the relative measures are being driven by changes in a particular market. Over time we see that Canadian percentage spreads increase in the period 1996-2000, while the US spreads actually decrease until 1999. Surprisingly, while the relative spreads increase, making Canada less competitive, Canadian component shares increase. After a spike in US spreads in 2000, the year of the dot-com bubble, we see a period of marked declines in spreads on both markets. Around 2000 and 2001 most of the US exchanges moved to decimilised spreads which may explain the rapid decline between 2001 and 2003. Interestingly, around the same time spreads in Canada also reduce, although not as sharply. This period also represents the first point in time where spreads in the US are cheaper on average than in Canada. While this does not perfectly coincide with the period of US gains in price discovery in the period 2003-2006, it likely plays a role in the US improvements in the component shares. Further, the period from 2008 sees Canada become the cheaper market, which also coincides with the TSX regaining a

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[4]Relative numbers are computed for the cross-listed stocks that are in our sample.

considerable amount of the contribution to price discovery. The relationship with spreads is not perfect and it does not explain well the period 2000-2002 or 2007-2009.

<Insert Figure 4 Here >

In Column 3 of Panel A of Table 3, we report the relative number of quotes (i.e. the number of quotes issued on the TSX versus the number of quotes issued on the US markets for the cross-listed stocks in our sample). From 1996 onwards the relative number of quotes decreases considerably starting off at a situation where the TSX number of quotes is 4 times as high as the US markets and going down to 0.8, where the number of quotes on the US market is 1.25 higher than the TSX. From 2005 onwards the relative number of quotes increases again up to 2009. To determine what causes this pattern in relative number of quotes we turn to the absolute number of quotes reported in Panel B. We can clearly see an uptrend in quoting activity in both markets. In the earlier part of the sample, US quoting activity increased more than that in Canada. In the later part of the sample, from 2006 onwards, the quoting frequency in Canada grows at a faster rate, roughly doubling in number each year between 2005 and 2008. Again however, the changes in quoting activity do not appear to correlate well with the changes component shares. Neither the marked spikes in 2000 and 2002 appear related, although there are slight increases in relative quotes in those years. In addition, the number of relative quotes starts to increase in 2004, the middle of the period where Canadian component shares are decreasing.

The fourth column in Panel A of Table 3 reports the relative number of trades. Interestingly, we observe that the relative number of trades has remained relatively consistently high up to 1999, where it increases sharply in 2000. However, in 2001 we see a sharp decrease to 3.6 followed by a period of gradual decline until 2005. Again we see the increase in the relative measure in the 2007-2009 period. Panel B reveals that this big drop in relative trades is mainly due to a large increase in the trades occurring in the US markets. While trades increase in both markets, there is faster growth in US trades, particularly from 1997 until 2008. In particular we see a big increase in trade numbers in the US markets in 2001 and again in 2003. Canadian companies actually enjoy greater trading numbers in the US from 2003-2006 after which we see a significant increase in Canadian trading. The pattern in

trades appears to explain reasonably well the patterns in the component shares. The higher Canadian trade numbers up until 2000 is matched by the slight increases in Canadian component shares. The second spike in component shares in 2002 doesn't appear well related to relative trades, but we then see a period where the US is the more liquid market on average which coincides with the gains made by the US exchanges in price discovery.

The fourth column in Panel A of Table 3 reports the relative volume, which shows a very similar pattern to the relative number of trades, i.e. relative volume stays relatively high up to 2000, and then drops considerably in 2001. After 2001 we see that the relative volume continues to decrease until 2006 at which point it again starts to climb. Panel B shows similar patterns to the trade numbers, with growth in most years for the volumes traded in both Canada and the US. For the US we see that growth in volume increases significantly around 2000 before slowing down in 2003. Also of note is the decline in volume traded in the US from 2007 onwards. While this explains some of the increase in relative volume, there is also a significant increase in volume traded in Canada in 2007. As with the relative trades, the volume fits the changes in component shares reasonably well, with the 2000-2002 period still not well explained.

The results of all four measures of liquidity and trading activity show similar patterns. Initially Canada is in a superior position to the US markets for Canadian cross-listed companies although the US gains ground in spreads and quotes. Sometime around 2000-2001 we see that the there is a marked change in the speed with which the US gains against the Toronto Stock Exchange. This growth spurt may be the result of the decimalization which occurred around 2000 and certainly appears to have had a marked impact on spreads. The other apparent pattern in the data relates to the period around 2006 and 2007. This appears to represent a high water mark for the US exchanges against the Toronto exchange and in 2007 we see the TSX regain lost ground. 2007 coincides with the start of the Global Financial Crisis and it may be that during the crisis period resulted in investors being less willing to invest in foreign shares, causing a flight back to the home market, or it may be that the US exchanges were disproportionately affected by the crisis. In support of the later, we see a worsening in all measures for both exchanges, but the changes for the US exchanges are larger.

Table 4 presents the same four measures of liquidity and trading but for the US companies cross-listing into Canada. The smaller numbers of observations in each year make the trends and patterns less clear and therefore harder to interpret. Again we start with the relative spreads. The relative spreads do not appear to have a consistent trend in the data. Likewise, when we look at the spreads on both exchanges there are few apparent trends in either market. Spreads stay fairly consistent over much of the sample period with a period of lower spreads in the US between 2002 and 2007. Although we do observe what appears to be an increase in spreads around the time of the GFC.

< Insert Table 4 Here >

Column 2 of Panel A presents the relative number of quotes for the two countries. There is a noticable decline in relative quotes between 1996, when Canada was providing more of the quoting, and 2002, when the US is providing nearly twice as many quotes. However, after this period we see a reversal, with the quoting activity on the Toronto Exchange gaining and eventually ending in a stronger position than it started in 1996. When we look at the per country values in Panel B we do see that both countries observe an increase in the average quotes produced. The US grows sharply in the early years such that in 2002 there are on average nearly twice the quotes. At that point however the Canadian exchange starts to grow more rapidly. Changes in the relative quotes also track reasonably well with the changes observed in the component shares with the same decline in component shares until 2002, although the stagnant period in component shares between 2003 and 2007 is not reflected in the increasing relative quotes.

< Insert Figure 5 >

Column 3 of Panel A presents the relative trades. We observe a similar pattern to that of the relative quotes, namely a relatively long period over which the relative trades reduce, indicating that more trades are being executed on the US exchanges. However, unlike quotes we observe a marked increase around the 2000-2002. After 2004 the relative trades increase over the rest of the sample period. When we look at the average numbers we see that up until

2000 more trades are being executed on the TSX. This drops away sharply, and may be a consequence of either new cross-listings or companies that have dropped out of the sample. Of note, we do not see much growth in the number of trades executed in Canada until around 2007, while the US sample shows quite steady growth up until around 2006. The growth in Canadian trades maybe explained by the AMEX listings as it occurs around the time that listings on the AMEX increase markedly. Of note, while the TSX has considerable growth in its quoting activity, the trade numbers up until 2007 stay very low and show little evidence of increasing. This may be due to the much higher spreads resulting in investors choosing to trade in the cheaper venue. Unlike for the Canadian cross-listed companies, relative trades do not appear well related to the changes in component shares.

Column 4 of Panel confirms the patterns seen in the relative trades when we look at relative volumes. Again we see a decline in relative volume that lasts until roughly 2006, with an increase in 2001. Around 2007 relative volume starts to increase again. Columns 7 and 8 of Panel B present similar patterns to those observed in relative trades, little to no growth in the volume traded in Canada until roughly 2007 at which point we see a marked increase in the volume traded. The US volume numbers however demonstrate reasonably consistent growth. Given the timing of the turnaround in Canadian volume traded, the increase in the AMEX firms listing on the TSX may explain the growth in volume. Again, the relative volume numbers do not appear related to the changes in component shares.

As with the Canadian firms listing on the US exchanges, we see similar patterns across the four measures. Initially the Toronto Stock Exchange loses ground to the US exchanges, particularly in terms of little evidence of a growth in trades and volume, until around the 2007 period where the Toronto exchange gains both trades and volumes. This coincides with the period when more AMEX firms move onto the TSX and may support the idea of an evolutionary process in exchange competition. What we do not see is evidence that the US exchanges are making the Canadian exchanges irrelevant for US companies.

Survivors Sample

As a robustness check for the patterns we identify in the full sample, and to ensure that the changes in component shares and the trade and liquidity measures are not driven by new cross-listings or the removal of firms (as a result of delisting on one or both exchanges), we look at a sub-sample of just those firms that were cross-listed over the entire sample period. This significantly reduces the size of the sample as just 19 companies were cross-listed for the entire 14 year sample. After we exclude several companies that were missing a number of firm-year observations we were left with just 17 companies and 228 firm years[5]. Further, no US companies listing on the Toronto Stock Exchange covered the entire 14 year period. As a result, we do not analyze the US companies cross-listing onto the TSX.

Panel A of Table 5 presents the component shares for the Canadian companies listing on the US exchanges. The first column presents the full sample average per year. The component shares are broadly supportive of the full sample findings. We find on average the home exchange is the dominant market for price discovery although the average is only just above 50% in most years. Further the patterns shown in the full-sample are equally evident for just those stocks that survived the entire period. We see an initial decline in price discovery in Canada until around 2002 at which point the component shares increase sharply. After that we again see the component shares decline to a low in 2006, before we witness an even sharper reversion back to Canada, possibly due to the GFC. This pattern is repeated almost exactly in both the NYSE and NASDAQ. The AMEX pattern is slightly different in that the low point occurs in 2004 after which the TSX recovers its component share and then stays relatively stable over the rest of the period with only a slight jump in 2008 and 2009.

< Insert Table 5 Here >

Panel B provides the trade and liquidity averages per year for the 17 companies that survived the entire period. Column 1 presents the percentage spreads in each of the markets. Spreads in Canada start off lower, with spreads in both markets relatively static until 2000 when they increase sharply. Following this spike in 2000, spreads in both markets fall sharply to levels lower than in the 1990's, although the spreads in the US fall by a greater amount and are

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[5] In most cases this was a result of either having too few trading days, non-stationarity or no-cointegrating relationship in a particular firm year. As a result we remove two companies that had less than 10 of the 14 firm-year observations. 10 of the 17 remaining companies had 14 firm-year observations.

actually lower than in Canada. This reduction in US spreads appears to drive an increase in quoting, trading and volume in the US. However, while there is a sharp increase in trading and volume, the component share in the US falls around this period. Spreads in both markets continue to fall although the US remains lower until 2007 when both markets see increases in spreads, likely as a result of the market instability at the time.

< Insert Figure 6 >

Around 2003 we also see quoting and trade activity in the US overtake Canada. This activity continues to be greater until 2005, after which the Toronto market overtakes the US exchanges again, with particularly strong gains in 2008. The results suggest that there is a relationship between the trading and quoting activity on the markets and the changes in component shares. In the period between 2003 and 2005 we see US component shares improve markedly at the same time as they become the larger market for trading and quoting in the companies. However, the relationship is not complete, in 2006 we see the lowest component shares, yet the importance of the Canadian market for trading and quoting has greatly improved. Further, the spike in component shares in 2002 appears unrelated to any of the measures. The 2000-2002 and the 2007-2009 periods however do represent crisis periods, which may suggest that price discovery reverts to the home market in such periods.

As a further robustness check on the trends in the component shares, we split the sample by four measures that should influence the relative contributions to price discovery. We split the sample by calculating the firm average of each measure. Based on the firm average over the years that a company is cross-listed we then calculate the top and bottom 30% of firms. The first factor we split the sample by is the percentage of sales occurring in the US. One argument used to explain cross-listing destination is that companies list where they have sales as a way of overcoming with a lack of investor familiarity with the company (). Therefore we would expect companies with more US sales to be more familiar to US investors and possibly result in more price discovery occurring in the US. Panel A of Table 6 indicates that the firms with higher US sales have a lower Canadian component share. In fact, for firms with a high percentage of their sales in the US, the US exchanges are dominant with an average

contribution to price discovery of 55%. By contrast, for firms with low US sales the TSX contributes on average 68% of the price discovery.

The second factor we employ is market capitalization, as larger firms are more likely to receive attention from US investors, media and analysts. The results do not support this however. Smaller firms have more price discovery in the US, nearly 50%, while larger firms retain more price discovery at home. However, the gap is much smaller, roughly 10%. The third factor is relative trade numbers, calculated as the number of Canadian trades divided by the number of US trades. The low relative trade group, or those companies with a greater number of US trades, have a greater US contribution to price discovery, averaging 37%, while those with more Canadian trades have a much higher Canadian component share, 77%. The final factor we employ is relative spread, calculated as the ratio of Canadian percentage spreads to US percentage spreads. Leiberman et al. (1999) and Hasbrouck (1995) both show that the ratio of spreads between two exchanges is a key determinant of the relative contribution to price discovery between the exchanges. As Panel A shows, those firms with low Canadian spreads (low relative spread) have on average 77% of their component shares on the TSX. Those firms with higher relative spreads in Canada on the other hand have just 39% of their price discovery in Canada. Further, we see that there is a greatly reduced standard deviation for the low relative spread group and high relative trade group. The four factors all appear to explain differences in the level of the price discovery contributions of the US and Canadian exchanges.

Panel B presents the Canadian component shares for each of the sub-samples over time. In almost every case we see a similar pattern occur. Canadian component shares increase around the period 2000-2002 with a peak in 2002, after which the US contributions increase as Canadian component shares decrease, which represents the lowest point for the Canadian component shares. As with the earlier results, we see a significant increase in the component shares during the 2007-2009 period, around the time of the GFC. This pattern remains consistent irrespective of how we separate the sample and is strongly suggestive that our results are being driven by changes in the competitive position of the markets, potentially for information trades. Of particular note is the effect of the two periods 2000-2002, around the period after the dot-com bubble bursts along with the crises in corporate governance in the

wake of Enron, and 2007-2009, the GFC period. The results suggest that at least for Canadian companies price discovery reverts to the home market in a crisis period.

Figures 7-10 show graphically the component shares of the high and low measure groups for each of the four determinants of the level of price discovery. Three of the four graphs, namely those for US sales, relative trades and relative spreads, show that while the measures explain the level of price discovery for a particular firm, they do not appear to explain the changes over time in the relative contributions to price discovery of the US and Canadian markets. Particularly for trades and spreads the two lines move in similar fashions and appear to track each other reasonably well. The graph for US sales shows a similar tracking after 2001, although prior to that point there appears to be some convergence. Only market value offers a different picture with the two groups converging around 2006, although only for a brief period before they begin to move apart again. The graphs also do not support the belief that the Canadian component shares are decreasing noticeably over time, instead looking more like the ebb and flow process described in Harris et al. (2002).

< Insert Figures 7-10 >

7. Conclusion

Given the increasing integration of markets around the world, concerns have been expressed about the survival of smaller national exchanges in competition with larger, more liquid exchanges. Several theories have been put forward regarding the likely long-term survival of smaller exchanges, but little actual empirical evidence has been presented to suggest which of the theories, if any, are correct. Much of the evidence that has been presented to date looks at the Canadian stock exchanges. Canada and the US have undergone decades of integration allowing Canadian firms and investors easy access to US markets. Canadian firms also represent the largest block of foreign companies cross-listed on the US exchanges. Evidence in this setting therefore offers useful insights into the likely consequences for other smaller exchanges in other parts of the world that are now undergoing similar integration efforts. Measures of the relative contributions to price discovery also offer an excellent way of looking at the competitiveness of exchanges. However, few papers have measured price discovery over a long time period so to date evidence on the evolutionary development of price discovery has not been explored.

Our findings show little evidence that the Toronto Stock Exchange is systematically losing ground to the US exchanges, either in relation to price discovery or trading and liquidity measures. We do however find that there is time variation in the contributions to price discovery of the various exchanges. Specifically, overall we find that the home exchange dominates price discovery, but for Canadian companies the overall average Canadian component share reaches a low point in 2006 where the US is slightly dominant. However, particularly during crisis periods we see that price discovery migrates to the Canadian exchange, particularly during the Global Financial Crisis (GFC). The patterns also differ depending on the exchange firms are listing to or from. In particular we find that the AMEX exchange has lost competitiveness to the TSX fairly consistently over the sample period. We also find only mixed evidence that the change in component shares are related to changes in trading and liquidity measures, in particular relative spreads, trading and quoting activity and volume traded. Overall the results appear to support the findings of Harris et al. (2002) that the competitive position of exchanges will ebb and flow as they compete.

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Table 1: Number of Cross-listings per year

Year	Canadian Cross-listings				US Cross-listings			
	Total	NYSE Listings	NASDAQ Listings	AMEX Listings	Total	NYSE Listings	NASDAQ Listings	AMEX Listings
1996	43	20	14	9	7	2	3	2
1997	64	30	21	13	9	5	2	2
1998	68	32	24	12	12	6	5	1
1999	77	35	30	12	12	6	6	0
2000	90	39	38	13	13	9	4	0
2001	91	39	43	9	12	7	5	0
2002	94	45	37	12	12	7	4	1
2003	102	44	42	16	12	7	3	2
2004	116	47	41	28	7	5	2	0
2005	125	50	43	32	11	7	3	1
2006	129	51	39	39	12	6	4	2
2007	132	49	35	48	19	4	6	9
2008	129	45	36	48	20	3	6	11
2009	121	36	35	50	17	3	3	11

Note: This table reports the number of cross-listings per year from the TSX to the various markets in the US. We report the total number of cross-listings and cross-listings on the NYSE, Nasdaq and Amex, respectively.

Table 2: Canadian Component Shares by Exchange and Country

Panel A: Component Shares By Exchange for Canadian Companies Cross-listings					
	Average	Std Dev	Min	Max	Number
TOTAL	0.5718	0.2177	0.0269	0.9939	1,381
NYSE	0.6331	0.2024	0.0738	0.9939	562
NASDAQ	0.4351	0.2042	0.0269	0.9426	478
AMEX	0.6624	0.1600	0.1122	0.9570	341

Panel B: Component Shares By Exchange for US Companies Cross-listings					
	Average	Std Dev	Min	Max	Number
TOTAL	0.3772	0.2520	0.0120	0.9199	170
NYSE	0.3873	0.2287	0.0261	0.8134	56
NASDAQ	0.2652	0.2303	0.0120	0.9199	73
AMEX	0.5627	0.2064	0.0634	0.8644	41

Panel C: Component Shares by Time								
	Canadian Companies				US Companies			
	Total	NYSE	NASDAQ	AMEX	Total	NYSE	NASDAQ	AMEX
1996	0.5630	0.6930	0.3714	0.5720	0.4585	0.3079	0.4521	0.6282
1997	0.5645	0.6393	0.4670	0.5493	0.3882	0.3310	0.5861	0.3335
1998	0.5756	0.6673	0.4585	0.5653	0.4010	0.2792	0.5223	0.5261
1999	0.5775	0.6707	0.4652	0.5860	0.3893	0.2674	0.5112	-
2000	0.5912	0.6713	0.5105	0.5868	0.3733	0.3288	0.4621	-
2001	0.5768	0.6783	0.4769	0.6145	0.2774	0.2292	0.3449	-
2002	0.6233	0.7282	0.5159	0.5607	0.2430	0.2349	0.2502	0.2712
2003	0.5867	0.6717	0.4782	0.6378	0.3134	0.2406	0.2564	0.6538
2004	0.5677	0.6261	0.4356	0.6629	0.2562	0.1779	0.4128	-
2005	0.5250	0.5701	0.3543	0.6841	0.3761	0.3072	0.3519	0.8624
2006	0.4873	0.5003	0.2783	0.6793	0.2428	0.1424	0.1655	0.6987
2007	0.5446	0.4986	0.3833	0.7091	0.3961	0.2317	0.3355	0.5096
2008	0.6305	0.6735	0.4311	0.7396	0.4970	0.3490	0.3325	0.6271
2009	0.6122	0.6895	0.4590	0.6637	0.5112	0.3911	0.5300	0.5389

Table 3: Trading and Liquidity Measures for Canadian Cross-listed Companies

Panel A: Relative Measures

	Relative Spreads	Relative # of Quotes	Relative # of Trades	Relative Volume
1996	0.718	4.284	6.643	11.561
1997	0.824	2.076	5.248	9.86
1998	0.867	1.439	5.169	8.8
1999	0.94	1.232	5.17	8.217
2000	0.958	1.357	7.374	9.688
2001	1.154	1.079	3.593	6.448
2002	1.129	1.142	3.666	6.857
2003	1.18	0.871	2.627	5.501
2004	1.295	0.809	2.319	4.391
2005	1.278	0.918	2.318	3.596
2006	1.315	1.386	2.367	3.487
2007	1.076	1.696	2.431	4.535
2008	0.918	2	2.999	4.707
2009	0.866	2.1	2.783	4.202
Total	1.07	1.484	3.794	6.568

Panel B: Per Exchange Measures

Year	% Spread Canada	% Spread US	# Quotes Canada	# Quotes US	# Trades Canada	# Trades US	Volume Canada (x10e8)	Volume US (x10e8)
1996	0.0162	0.0245	30,860	13,180	28,245	10,064	0.604	0.332
1997	0.0183	0.0239	35,553	22,838	30,107	10,139	0.550	0.283
1998	0.0200	0.0233	50,409	32,964	40,589	13,166	0.654	0.293
1999	0.0200	0.0222	67,319	48,091	57,826	20,786	0.705	0.331
2000	0.0208	0.0257	104,623	81,651	90,227	44,560	0.885	0.465
2001	0.0186	0.0170	165,252	162,337	79,987	61,555	0.920	0.550
2002	0.0179	0.0162	249,165	278,179	99,100	69,217	1.105	0.609
2003	0.0102	0.0093	374,816	433,893	106,798	117,141	1.084	0.868
2004	0.0111	0.0092	547,237	614,912	122,420	148,927	1.047	0.905
2005	0.0086	0.0074	882,077	1,044,813	179,388	256,216	1.169	1.042
2006	0.0090	0.0071	1,633,675	1,203,737	266,692	260,987	1.389	1.138
2007	0.0092	0.0093	3,152,497	2,690,646	401,275	398,576	1.785	1.090
2008	0.0180	0.0198	5,345,592	3,778,158	672,678	455,542	2.115	1.048
2009	0.0180	0.0200	4,882,516	3,661,979	463,403	360,898	1.533	0.849
Total	0.0147	0.0154	1,575,516	1,260,458	226,287	195,098	1.215	0.781

Table 3: Trading and Liquidity Measures for US Cross-listed Companies

Panel A: Relative Measures

	Relative Spreads	Relative # of Quotes	Relative # of Trades	Relative Volume
1996	1.617	2.698	2.578	21.605
1997	3.335	1.965	2.547	11.190
1998	6.015	1.003	1.729	6.965
1999	5.203	0.802	1.253	1.311
2000	3.875	0.945	2.608	1.283
2001	6.321	0.794	4.106	4.871
2002	8.475	0.602	2.248	2.058
2003	5.022	0.641	1.512	2.186
2004	3.150	0.752	0.261	1.696
2005	4.116	0.933	0.768	1.401
2006	4.161	1.073	0.399	0.576
2007	1.819	1.953	0.809	0.943
2008	2.490	2.460	0.974	1.145
2009	2.006	3.051	1.424	2.399
Total	4.107	1.491	1.591	3.280

Panel B: Per Exchange Measures

Year	% Spread Canada	% Spread US	# Quotes Canada	# Quotes US	# Trades Canada	# Trades US	Volume Canada (x10e8)	Volume US (x10e8)
1996	0.0289	0.0341	2,510	3,613	1,249	3,291	0.671	0.822
1997	0.0274	0.0149	12,068	14,452	6,133	4,803	1.626	0.813
1998	0.0523	0.0280	14,536	20,716	11,543	6,346	3.370	1.391
1999	0.0532	0.0287	18,120	21,848	16,665	7,679	2.678	1.361
2000	0.0565	0.0307	28,627	26,978	33,197	8,718	6.309	1.868
2001	0.0639	0.0233	23,010	57,212	8,097	7,740	0.807	0.810
2002	0.0447	0.0171	89,530	165,459	19,735	35,438	1.344	2.392
2003	0.0409	0.0196	131,752	212,986	21,180	53,898	1.890	2.045
2004	0.0154	0.0051	290,688	360,943	4,754	64,459	0.345	3.059
2005	0.0084	0.0045	618,738	733,676	20,902	136,362	2.299	9.231
2006	0.0414	0.0062	1,032,996	1,021,188	9,700	160,767	0.387	10.437
2007	0.0411	0.0141	1,071,383	1,109,432	34,975	161,866	1.637	8.380
2008	0.0617	0.0285	1,562,288	1,195,274	39,010	156,988	1.852	7.147
2009	0.0287	0.0210	2,807,066	2,139,156	63,911	229,253	3.997	6.240
Total	0.0430	0.0201	726,104	643,044	25,127	89,939	2.239	4.553

Table 5: Component Shares and Trading and Liquidity Measures for Surviving Canadian Cross-listed Companies

	TOTAL	NYSE	NASDAQ	AMEX
	Panel A: Component Shares			
1996	0.5316	0.7034	0.3691	0.5160
1997	0.5720	0.6257	0.5535	0.4897
1998	0.5489	0.6429	0.4480	0.5729
1999	0.5364	0.6382	0.4084	0.6284
2000	0.5026	0.6067	0.3580	0.5491
2001	0.5181	0.6396	0.3589	0.7815
2002	0.5990	0.7136	0.4573	0.6152
2003	0.5540	0.6653	0.4349	0.5725
2004	0.5383	0.6762	0.3904	0.5614
2005	0.4866	0.5751	0.3302	0.6449
2006	0.4225	0.4908	0.2588	0.6452
2007	0.4796	0.5447	0.3459	0.6395
2008	0.5579	0.6716	0.3849	0.6963
2009	0.6656	0.8075	0.5128	0.6913

Panel B: Trade and Liquidity Measures

Year	% Spread Canada	% Spread US	# Quotes Canada	# Quotes US	# Trades Canada	# Trades US	Volume Canada (x10e8)	Volume US (x10e8)
1996	0.0127	0.0163	44,016	18,170	42,548	14,655	7.32	5.14
1997	0.0145	0.0202	53,323	32,735	48,172	14,318	7.67	4.04
1998	0.0148	0.0145	87,713	51,383	74,412	25,079	11.04	5.15
1999	0.0146	0.0157	115,267	76,027	99,505	38,307	10.73	5.75
2000	0.0252	0.0315	172,086	112,791	165,237	58,656	14.77	8.57
2001	0.0088	0.0067	300,012	276,568	137,938	105,171	14.48	10.01
2002	0.0089	0.0084	393,346	387,014	158,487	123,927	16.40	11.22
2003	0.0068	0.0053	550,324	552,168	155,364	154,992	13.09	11.39
2004	0.0064	0.0046	801,684	850,397	185,677	233,885	13.80	12.11
2005	0.0044	0.0031	1,190,035	1,232,194	263,671	290,835	15.37	12.02
2006	0.0044	0.0029	2,244,403	1,690,330	423,935	410,996	19.68	15.42
2007	0.0048	0.0034	4,132,870	3,443,631	587,648	499,022	23.71	13.61
2008	0.0107	0.0079	7,623,763	5,273,664	1,042,234	578,616	30.26	12.68
2009	0.0061	0.0053	9,408,934	6,201,411	926,432	551,248	22.42	11.12

Table 6: Component Shares Seperated by Price Discovery Determinants

	Low US Sales	High US Sales	Low MV	High MV	Low Rel_Trades	High Rel_Trades	Low Rel_Spread	High Rel_Spread
Average	0.6767	0.4528	0.5124	0.6180	0.3714	0.7674	0.7733	0.3902
Median	0.6769	0.4677	0.5430	0.6429	0.3694	0.7881	0.7811	0.3850
Std Dev	0.2232	0.2057	0.1958	0.2184	0.1710	0.1348	0.1107	0.1753
Panel B: Trade and Liquidity Measures								
Year	Low US Sales	High US Sales	Low MV	High MV	Low Rel_Trades	High Rel_Trades	Low Rel_Spread	High Rel_Spread
1996	0.8024	0.4658	0.4135	0.6569	0.3209	0.7188	0.6907	0.2786
1997	0.7355	0.4243	0.4442	0.6576	0.3854	0.7423	0.7158	0.3678
1998	0.7774	0.4028	0.4698	0.6721	0.3738	0.7680	0.7610	0.3848
1999	0.7350	0.4307	0.4487	0.6804	0.3553	0.7501	0.7746	0.4184
2000	0.7421	0.5262	0.5426	0.6644	0.4011	0.7890	0.8008	0.4358
2001	0.6763	0.5450	0.4969	0.6555	0.3825	0.8223	0.8125	0.4249
2002	0.7713	0.5011	0.5254	0.6895	0.4399	0.8669	0.8684	0.4762
2003	0.6480	0.4722	0.5258	0.6342	0.4096	0.8134	0.8127	0.4412
2004	0.6389	0.4183	0.5209	0.6003	0.3651	0.7805	0.8031	0.3700
2005	0.6135	0.3954	0.4761	0.5339	0.2947	0.7522	0.7953	0.3046
2006	0.5218	0.3783	0.4564	0.4722	0.2615	0.6902	0.7373	0.2661
2007	0.5940	0.4089	0.5538	0.4875	0.3384	0.6967	0.7460	0.3318
2008	0.7351	0.5224	0.5872	0.6766	0.4252	0.8031	0.8187	0.4435
2009	0.6825	0.4925	0.5374	0.7205	0.4468	0.7830	0.7488	0.4782

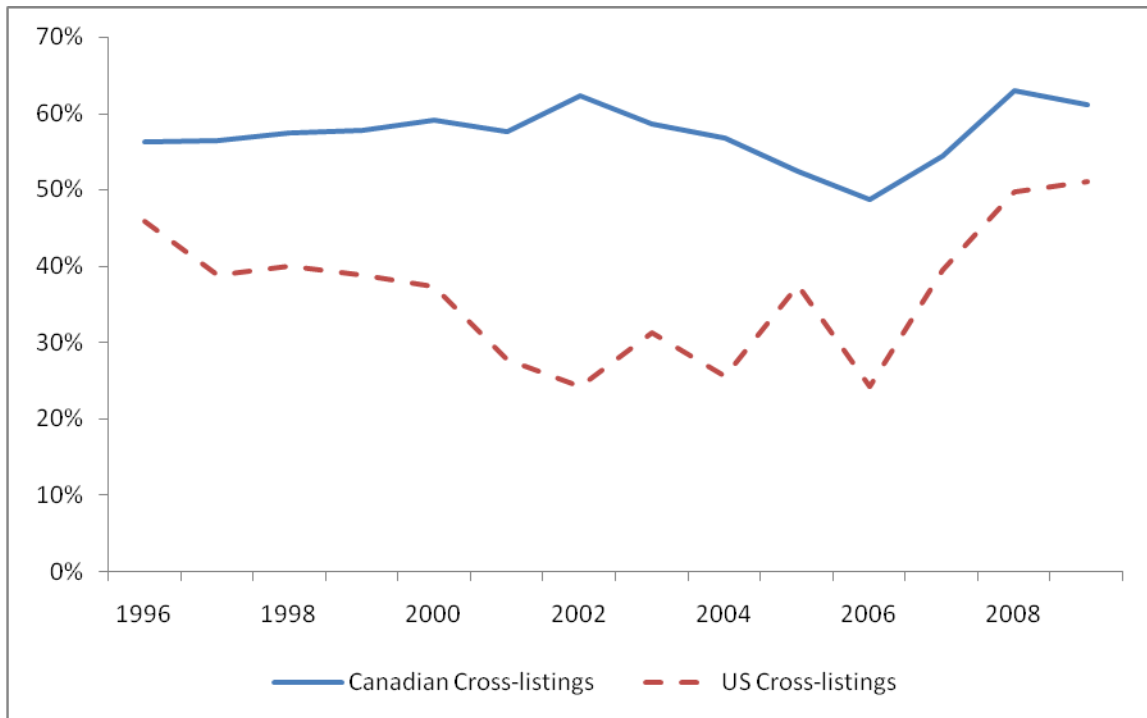**Figure 1: Component Shares for Canadian and US Cross-listed Companies by Year**

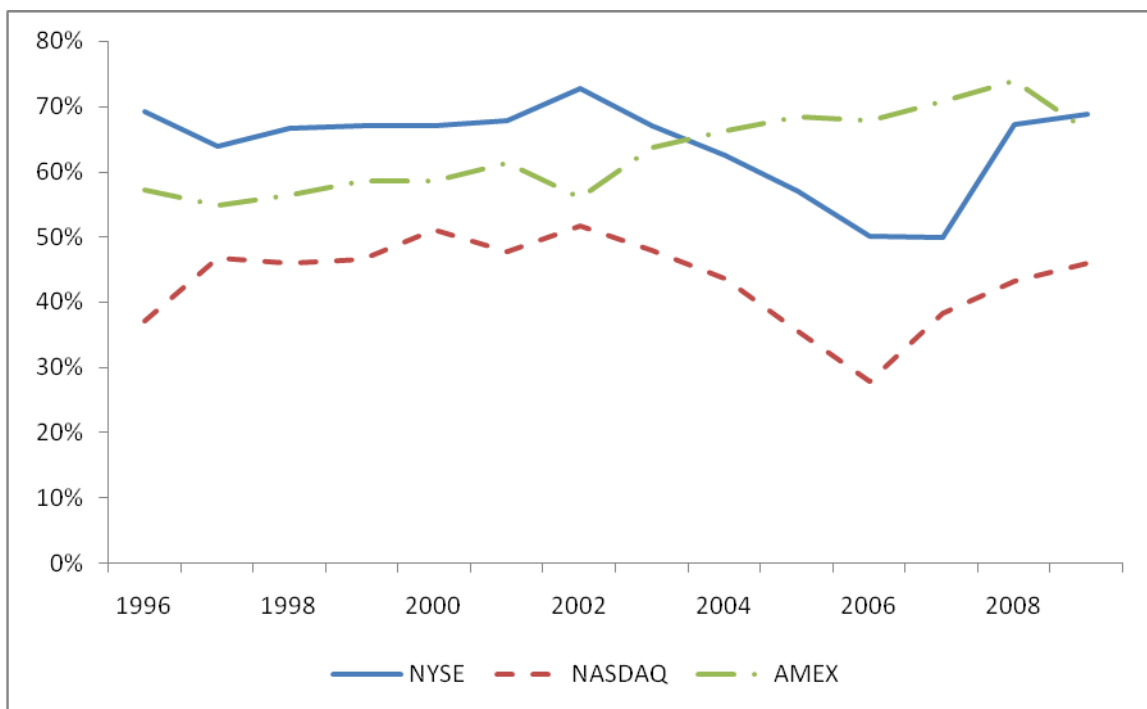**Figure 2: Component Shares for Canadian Companies by Exchange**

Figure 3: Component Shares for US Companies by Exchange
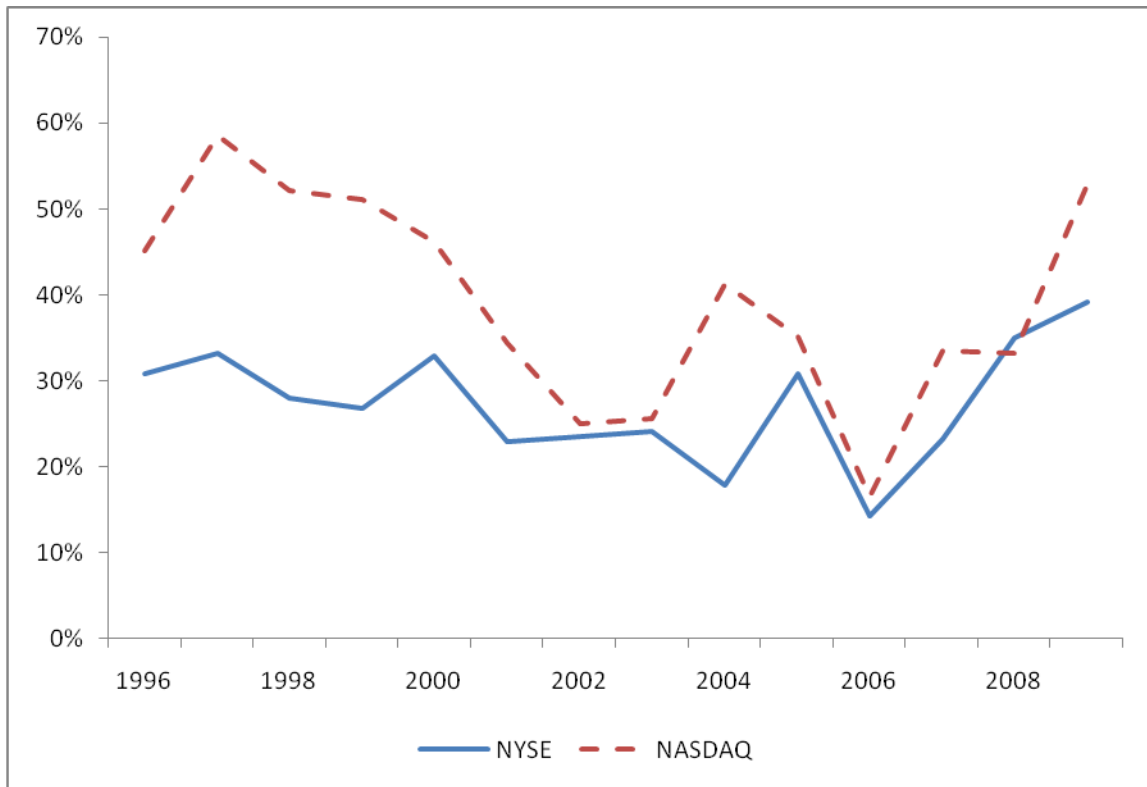

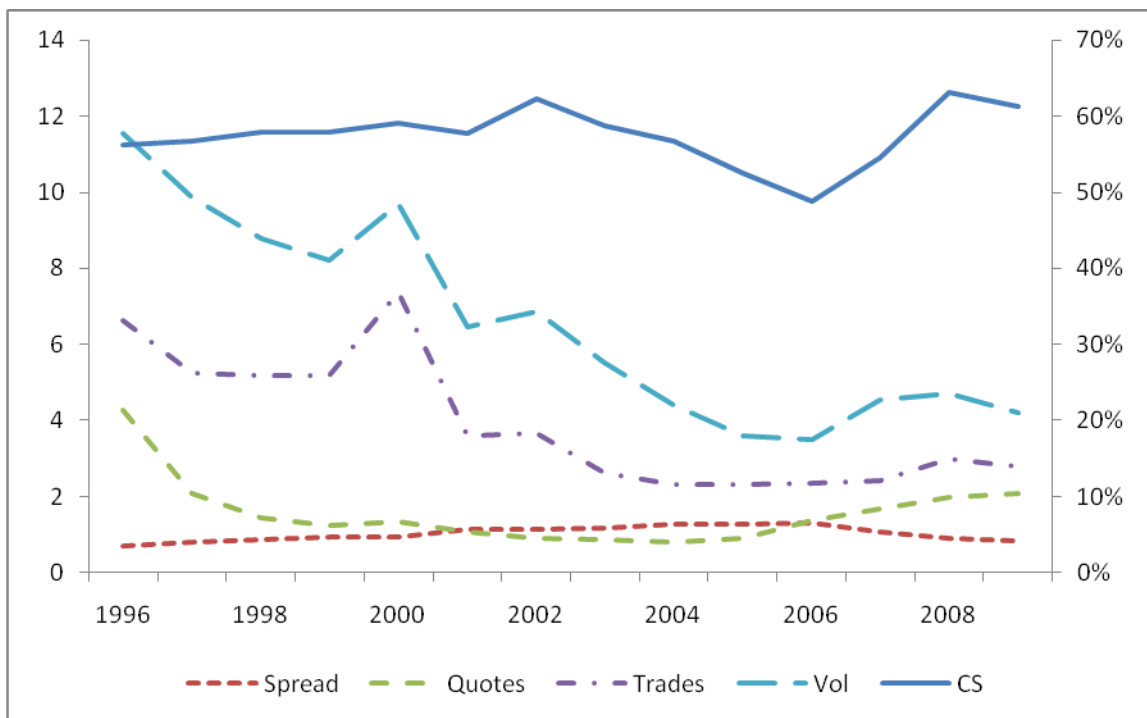**Figure 4: Component Shares and Trading and Liquidity Measures for Canadian Companies by Year**

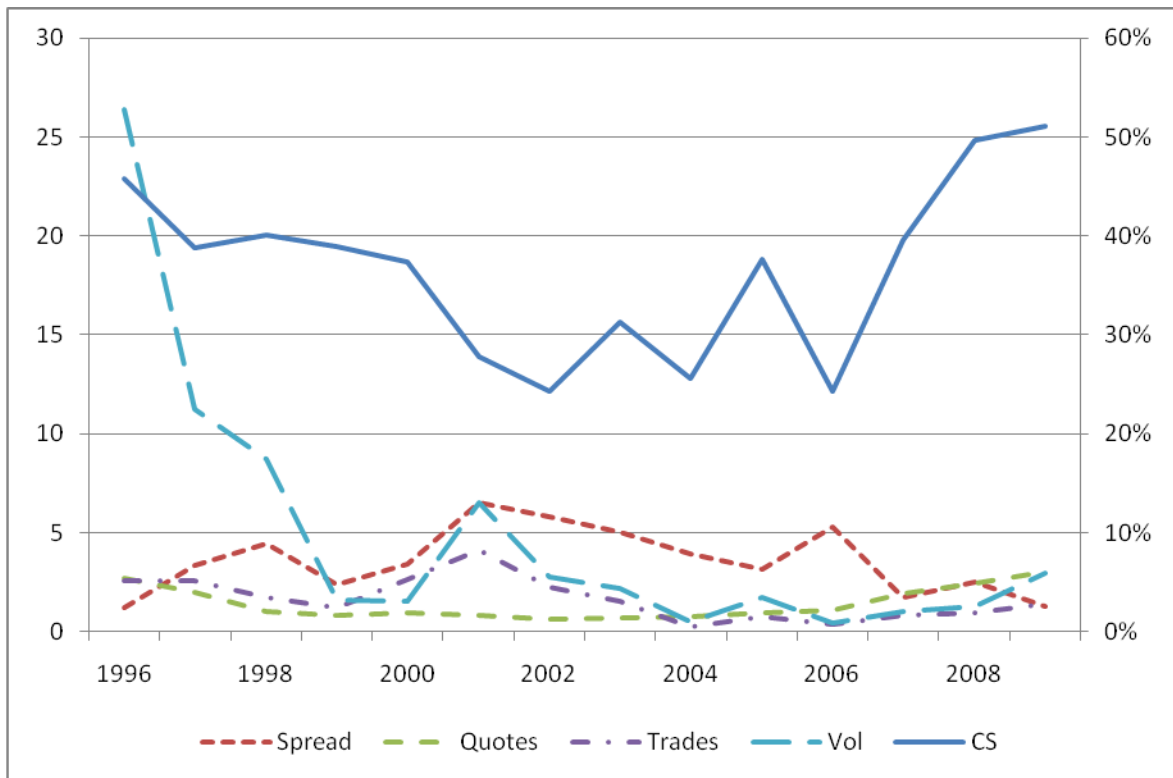**Figure 5: Component Shares and Trading and Liquidity Measures for US Companies by Year**

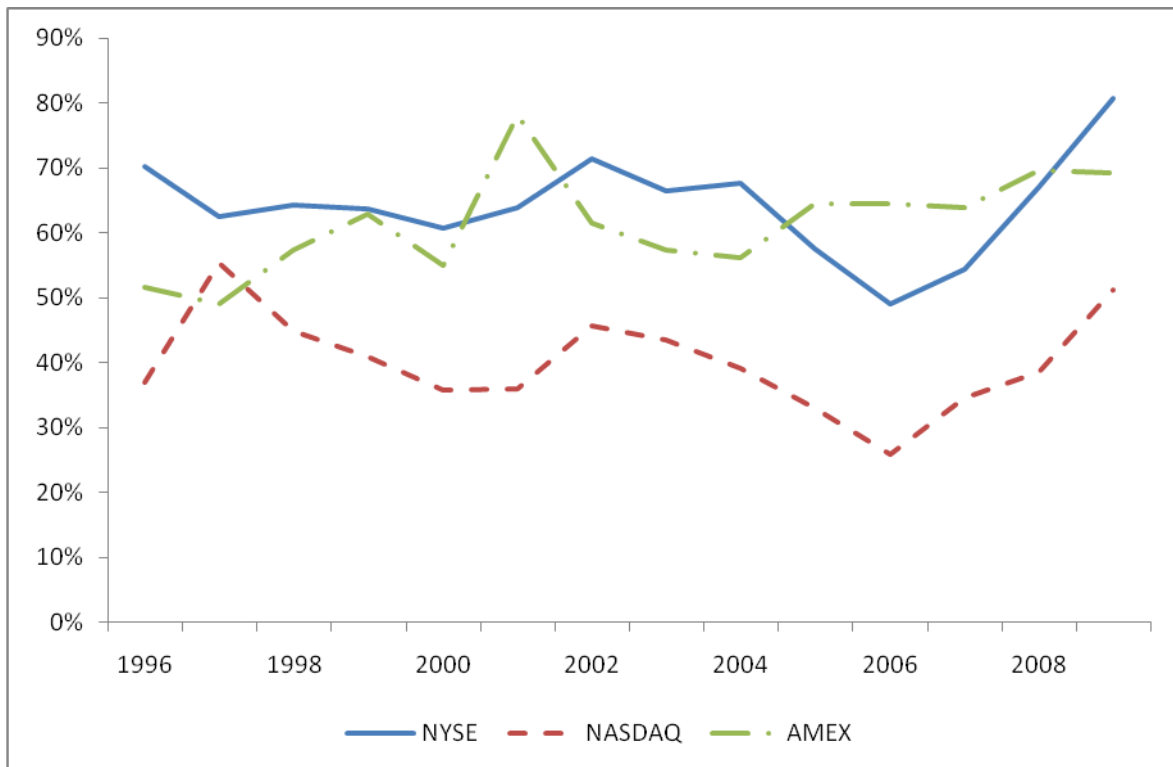**Figure 6: Component Shares for Surviving Canadian Companies by Exchange**
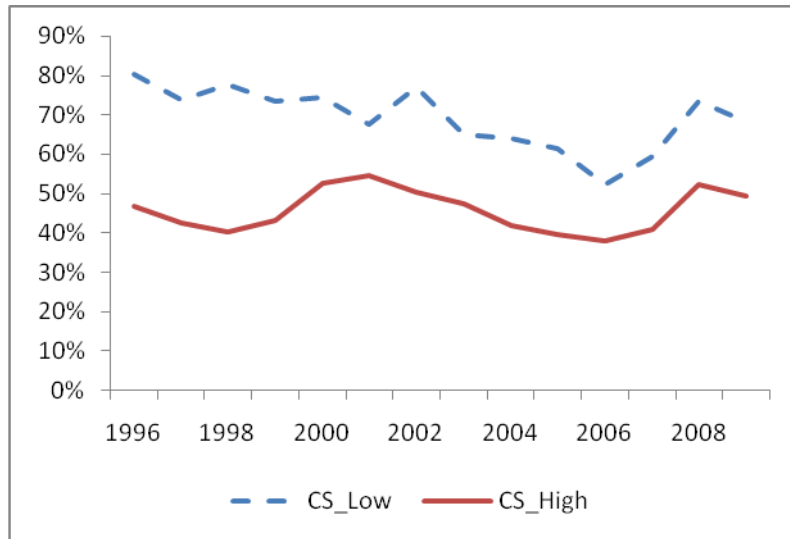
Figure 7: Component Shares by High and Low US Sales

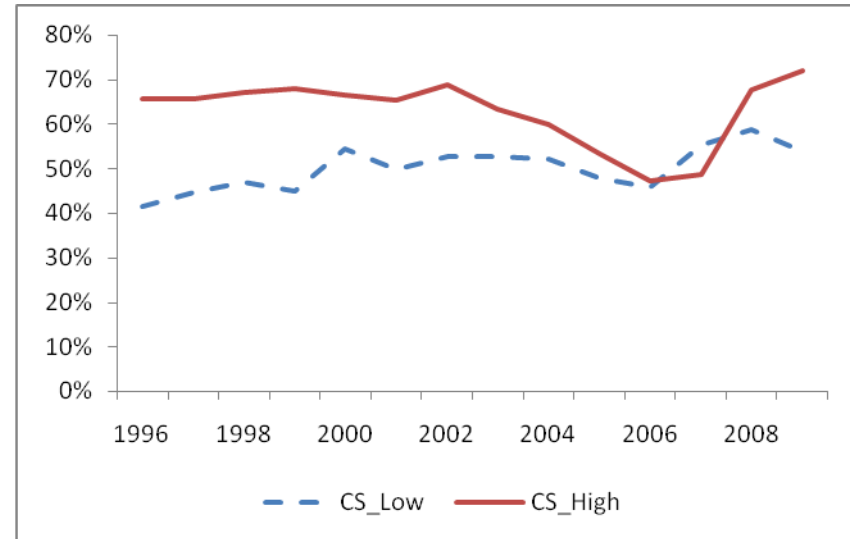**Figure 8: Component Shares by High and Low Market Value**
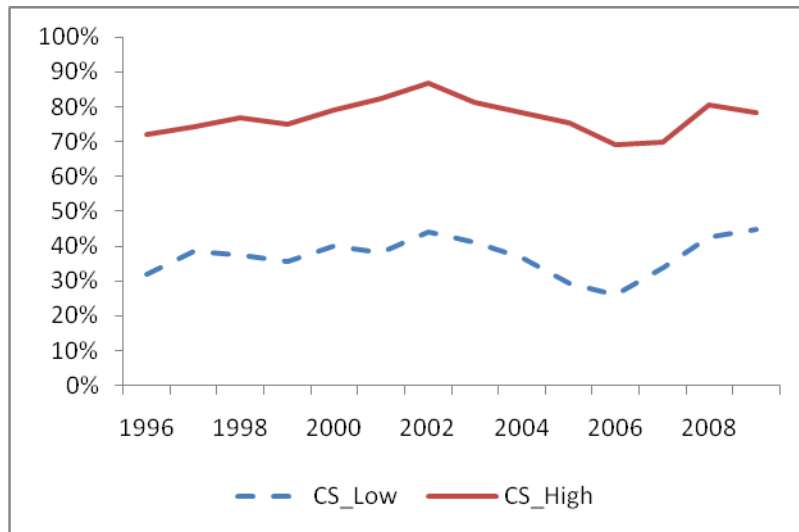

Figure 9: Component Shares by High and Low Relative Trades

Figure 10: Component Shares by High and Low Relative Spreads