Journal of Economic and Financial Sciences
ISSN: (Online) 2312-2803, (Print) 1995-7076

The impact of internationalisation on stock liquidity and volatility: Evidence from the Johannesburg Stock Exchange

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Dates:
Received: 27 Jan. 2017
Accepted: 25 Sept. 2017
Published: 09 Apr. 2018

How to cite this article:
Chipunza, K.J. & McCullough, K., 2018, 'The impact of internationalisation on stock liquidity and volatility: Evidence from the Johannesburg Stock Exchange', *Journal of Economic and Financial Sciences* 11(1), a161. http://dx.doi.org/10.4102/jef.v11i1.161

Maximising firm value remains a key tenet of corporate managers. Firms with lower illiquidity and volatility attract lower risk premiums, and these are associated with a lower cost of capital and higher firm value. Internationalisation is one avenue purported to provide liquidity and volatility benefits – possibly lowering both liquidity and volatility risk premiums. This study investigated whether South African domiciled stocks experience a surge in liquidity and/or decline in volatility subsequent to internationalisation. The findings show that internationalisation resulted in a surge in liquidity, and this increase was persistent as suggested by the trading volume and Amihud illiquidity measures of stock liquidity; however, the turnover measure indicated that such liquidity gains were temporary. Similarly, volatility declines after internationalisation were temporary. There was inconclusive evidence to show that internationalised stocks had higher liquidity relative to purely domestic shares, and no statistically significant difference between the volatility of internationalised and purely domestic shareholders' equity was noted. There is only weak evidence to support internationalisation as a route for lowering cost of capital via a reduction in the liquidity risk premium.

Introduction

In recent times, discussions on market and economic integration have become increasingly common, given that investor, corporate and government interactions are rarely limited within a single country. Of interest here is the ability of domestically listed firms to increase their presence beyond local capital markets via cross listing and cross trading (Chisadza 2014). Collectively, these two approaches are referred to as 'internationalisation of stocks', following Levine and Schmukler (2006) and Gozzi, Levine and Schmukler (2008). Cross listing occurs when an individual company establishes a secondary listing on a foreign capital market, in addition to listing on its domestic exchange (Chisadza 2014). In contrast, cross trading occurs when firms trade on over-the-counter (OTC) foreign capital markets. Alternatively, firms internationalise via dual listing, which is when two companies incorporated in different countries contractually agree to operate their businesses as if they were a single enterprise, while retaining their separate legal identities and existing stock exchange listings (De Jong, Rosenthal & Van Dijk 2009).

There are several reasons why firms may wish to pursue internationalisation, although, generally, these are categorised into two key areas. Firstly, it is argued that there are benefits that result from trading or listing in a foreign capital market, and secondly, it is argued that benefits arise because of the subsequent decline in information asymmetry surrounding a stock. The first area is referred to as 'conventional wisdom' by Karolyi (2006), and this encompasses a widening investor base (Merton 1987), lower market segmentation (Domowitz, Glen & Madhavan 1997) and augmented liquidity (Domowitz, Glen & Madhavan 1998). The second area is frequently further divided into the bonding and signalling hypotheses. The bonding hypothesis, proposed by Doidge, Karolyi and Stulz (2004), posits that increased disclosure and adhering to the legal obligations on a foreign exchange could enhance investor protection, and, as a result, lower agency costs. The signalling hypothesis suggests that firms may opt to internationalise their stocks on capital markets with more stringent disclosure requirements, in order to 'signal' that their stock is of a higher quality (Bris et al. 2012).

Although there are several theories and reasons presented for why a firm would be interested in internationalising their stock, the primary benefits may be argued to be those of increased liquidity and decreased volatility. In the context of this study, liquidity is defined as the degree to which

a financial asset can be exchanged at a relatively stable price over a relatively short period of time; whereas volatility is conceptualised as the rate at which the stock price moves up and down (Duteil & Mulugetta 2016). It may be argued that it is essential for firms to implement corporate strategies that result in increased liquidity and lower volatility of that firms stock. Generally, the reasoning is that an increase in stock liquidity and a decline in stock volatility may result in a reduction of the firm's cost of capital, *ceteris paribus*. In turn, the firm's value is augmented via the cost of capital, as the firm's cash flows will be discounted at lower rates. To attest this notion, Domowitz et al. (1998) argued that when stocks are listed on multiple markets, more traders demand firm-specific information. By so doing, prices become more informative, resulting in lower transaction costs, which ultimately augments stock liquidity.

Internationalisation of stocks is expected to increase the number of market participants following a stock, leading to the disclosure of more firm-specific information and resulting in lower asymmetric information. Anderson, Ghysels and Juergens (2005) note that investors are likely to have high information uncertainty under an opaque information environment. When stocks are internationalised, there is an enhancement of the information environment because of the mandatory information disclosure. Consequently, internationalisation can potentially minimise information differentiation among investors, as they access similar information – resulting in trading that induces less volatility. According to this viewpoint, enhancing the firm's information environment is a tool that managers can employ to reduce domestic stock volatility (Anderson et al. 2005). Others have argued that higher trading volumes subsequent to internationalisation of shareholders' equity could be associated with higher share volatility. This assertion contends that there is a positive correlation between volatility and volume of stocks (Choi et al. 2012).

Although several studies have examined the impact of internationalisation on domestic share liquidity and volatility, the current empirical evidence is mixed and far from conclusive. Foerster and Karolyi (1993), Mittoo (1997), Halling et al. (2008), Hedge, Lin and Varshney (2010), Dodd (2011) and Bris et al. (2012) all found that domestic stock liquidity increased subsequent to the listing event. Others have failed to find an increase in domestic stock liquidity subsequent to the listing event, for example, Bayer and Onder (2005) and Levine and Schmukler (2006). Leuz and Verrecchia (2000) and Bayer and Onder (2005) found that volatility of stocks increased after internationalisation of shareholders' equity; and contrary to Dodd's (2011) findings, Fernandes and Ferreira (2008) found that purely domestic stocks had higher volatility relative to cross-listed stocks.

The aforementioned findings are predominantly based on internationalised stocks with primary listing in European and Latin American markets. Very little is known about the impact of internationalisation on stocks domiciled on an emerging African market. This is interesting, as Figure 1 shows a growing number of South African companies domiciled on the Johannesburg Stock Exchange (JSE) (the largest stock exchange in Africa), which have internationalised their shareholders' equity via the OTC markets and foreign stock exchanges for the period 1990–2015. This cumulative growth in South African firms that are cross listed and cross traded on various foreign markets could suggest that firms may be seeking to derive the various hypothesised benefits that could arise from internationalising stockholder equity.

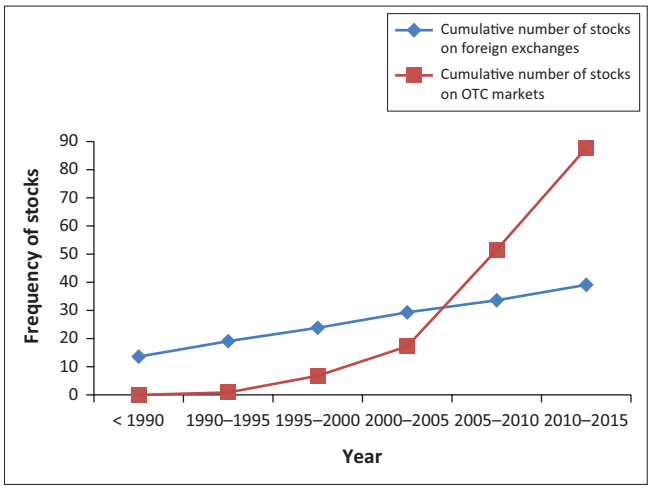

FIGURE 1: Cumulative number of internationalised shares in South Africa.

Empirical studies of cross-listed firms domiciled on the JSE have examined the impact of cross listing on stock price reaction around dual listing (Miller 1999), and the impact of cross-listing decisions on consumption of private benefits and control by controlling shareholders (Doidge et al. 2009). To the best of the authors' knowledge, there has not been an empirical investigation of the link between internationalisation of shareholder's equity and liquidity and volatility using companies with a primary listing on the JSE. As such, this study differentiates itself from previous works by Leuz and Verrecchia (2000), Bayer and Onder (2005), Fernandes and Ferreira (2008), Berkman and Nguyen (2010) and Dodd (2011) because it assesses the impact of internationalisation on stock volatility and liquidity from a perspective of stocks domiciled on an emerging African market. This could be insightful to the extent of assessing whether results could differ when impact of internationalisation on volatility and liquidity of stocks is considered using a sample of stocks domiciled on an emerging African market. Furthermore, this study tackles the question of sustainability of changes in stock liquidity and volatility subsequent to internationalisation. This component of our study is invaluable, as it provides a long-term perspective on whether additional costs of internationalisation could be compensated for by sustained improvements in stock liquidity and volatility. This article further provides a comprehensive analysis which presents several relevant methodologies to ensure that a complete representation of these impacts is presented.

Literature review

Several empirical studies have investigated the impact of internationalisation on domestic stock liquidity and volatility; however, the impact of internationalisation of stockholders' equity has been somewhat mixed. That is, while some empirical studies have found an increase in domestic stock liquidity, several other studies have found that domestic stock liquidity declined after admission to list and trade on a foreign exchange. Domowitz et al. (1998), Bayer and Onder (2005) and Levine and Schmukler (2006) pointed out that poor information linkages and fragmentation between the host and home markets could have contributed to the reduction in domestic stock liquidity that their studies noted. In addition, Silva and Chavez (2008) and Berkman and Nguyen (2010) showed that internationalised stocks do not always exhibit higher liquidity relative to purely domestic stocks.

Earlier studies by Foerster and Karolyi (1993) and Mittoo (1997) found that the increase in domestic stock liquidity was persistent; however, these studies tended to employ a relatively shorter event window period and failed to account for changes in firm- and country-specific factors. On the contrary, Halling et al. (2008) and Dodd (2011) employed relatively longer event window periods and controlled for firm and country characteristics. Halling et al. (2008) found that increased stock liquidity after the event date appeared to be short-lived; however, Dodd's (2011) results suggested that the surge in liquidity was more than a transitory phenomenon. Fernandes and Ferreira (2008) and Leuz and Verrecchia (2000) found that purely domestic stocks had significantly higher volatility in juxtaposition to internationalised stocks, whereas the opposite was true according to Dodd's (2011) findings. Therefore, there is no clear-cut evidence to suggest that internationalisation of stocks could result in sustainable increases in liquidity or decreases in volatility.

Several studies have examined stocks domiciled in developed European and emerging Latin American markets, which were then internationalised on the United States (US) exchanges. To the best of the authors' knowledge, however, there has been no study on the impact of internationalisation on the volatility and liquidity of stocks from an emerging African market perspective. This considered, this article contributes to the literature by investigating the impact of internationalisation on the domestic stock volatility and liquidity of South African stocks cross listed and cross traded on international markets. A comparison is made of volatility and liquidity before and after internationalising, the liquidity and volatility of internationalised shareholders' equity against that of purely domestic stocks is determined, and, furthermore, the possible influence of firm-specific characteristics are considered. The evolution of changes in liquidity and volatility around the event date are also examined in order to gauge whether changes were persistent or transitory. As the key goal of financial management is to maximise firm value, studies on how internationalisation affects stock liquidity and volatility are tacitly investigating whether corporate managers could increase the value of their firms via this route.

Data and sample construction

Of the stocks domiciled on the JSE and simultaneously listed and traded on various foreign exchanges and markets, 90 JSE domiciled stocks were found to have secondary listings. In addition, 87 South African Level 1 American Depository Receipts (ADRs) traded OTC in the US. Several parameters were imposed. Firstly, the JSE had to be the primary listing point. Secondly, only shares with data available 3 years prior and subsequent to the event date were included, in order to observe long-term changes in domestic liquidity and volatility around an event date. Lastly, the study only considers the period 1990–2014 because of data availability. The final sample comprised 40 internationalised shares.

A matched sample design was employed following Silva and Chavez (2008), Berkman and Nguyen (2010) and Dodd (2011), whereby internationalised stocks were compared against purely domestic stocks by selecting a matched sample closest to each of the internationalised stocks in terms of market capitalisation around the event date. For demarcating the period prior to and after internationalisation, the event date was obtained from the JSE for cross-listed stocks, and from Yahoo Finance for the date on which South African ADRs commenced trading on the US OTC markets. Following Bris et al. (2012), amongst others, the listing date was employed as a proxy for the event date. Stock- and firm-specific data, including high and low prices, volume, market capitalisation, leverage and total assets, were obtained from McGregor's Bureau of Financial Analysts database.

Liquidity and volatility measures

Liquidity measures comprised trading volume (Bris et al. 2012; Halling et al. 2008; Leuz & Verrecchia 2000), turnover ratio (Dodd 2011; Mittoo 1997) and the Amihud (2002) illiquidity measure (Levine & Schumkler 2006). Volatility measures included close-to-close (Domowitz et al. 1998; Leuz & Verrecchia 2000) and the high-low ratio (Dodd 2011). These measures are well established in the literature, and so only a brief discussion of these follows. The use of all of these measures is intentional; and is aimed at providing a comprehensive discussion of liquidity and volatility impacts in this market. Throughout these measures the use of log form is implemented where appropriate, as conversion of variables into their natural logarithm is known to make within-group variability more similar and to reduce skewness by creating a more symmetric distribution of the variables (Halling et al. 2008).

Trading volume is the natural logarithm of average trading volume of stock *i* over the daily trading volume of stock *i* on day *t*:

$$\text{Ln}\left(\text{Average Trading Volume}_{i,t}\right) = \text{Ln}\left(\sum \text{Trading Volume}_{i,t}\right) \quad \text{[Eqn 1]}$$

Turnover ratio is the natural logarithm of the product of each stock's daily trading volume and closing price of stock *i* on day *t* – divided by the market capitalisation of stock *i* on day *t*:

$$\text{Ln}\ (\text{Average Turnover Ratio}_{i,t}) = \text{Ln}\left(\sum \frac{\text{Closing Price}_{i,t} \times \text{Volume}_{i,t}}{\text{Market Capitalisation}_{i,t}}\right) \quad \text{[Eqn 2]}$$

Amihud (2002) illiquidity is calculated in two steps:

Firstly, daily absolute log returns for each stock *i* on day *t* were computed as follows:

$$\text{Absolute Log Returns}_{i,t} = \left|\text{Ln}\left(\frac{\text{Closing Price}_{i,t} + \text{Dividend Income}_{i,t}}{\text{Closing Price}_{t-1}}\right)\right| \times 100 \quad \text{[Eqn 3]}$$

Secondly, absolute daily log returns for stock *i* on day *t* were divided by the trading volume of stock *i* on day *t* and expressed in its natural logarithm as shown in equation 4:

$$\text{Ln}(\text{Amihud illiqiduity}_{i,t}) = \text{Ln}\left[\left(\sum \frac{\left|\text{Returns}_{i,t}\right|}{\text{Volume}_{i,t}} \times 10^6\right)\right] \quad \text{[Eqn 4]}$$

Following Amihud (2002) and Levine and Schmukler (2006), the Amihud (2002) illiquidity measure was rescaled by a factor of 10^6 to ensure that the figures will be sufficiently large for analysis. Furthermore, this is in keeping with several other studies in this area, allowing for easier comparison to be made between findings. Following Brooks (2008), close-to-close is estimated as the standard deviation of close-to-close returns:

$$\text{STDEV}_{\text{cc}\,(i,t)} = \frac{1}{N}\sum_{i=1}^{N}\left(x_i - \bar{x}\right) \quad \text{[Eqn 5]}$$

where x_i is the logarithmic returns for the closing price, $\bar{x}$ is the mean log return in the sample and *N* is the sample size.

High–low ratio is estimated as the natural logarithm of the ratio of the highest price achieved in a day, to the lowest price achieved in a day:

$$\text{High Low}_{i,t} = \sum\left[\text{Ln}\left(P_{\text{high}\,i,t} / P_{\text{low}\,i,t}\right)\right] \quad \text{[Eqn 6]}$$

Previous studies like Halling et al. (2008), Berkman and Nguyen (2010) and Dodd (2011) have acknowledged the influence that firm characteristics could have on changes in liquidity and volatility subsequent to admission to a foreign exchange. That is, it is inadequate to track changes in liquidity and volatility after internationalisation of stocks without also controlling for firm-specific factors. Smaller firms tend to have less information disclosure relative to larger firms as larger firms are expected to be more liquid (and because of higher asymmetric information associated with smaller firms it is possible that investors will trade smaller shares in a manner which induces return volatility). Firm size was incorporated by estimating the natural logarithm of the average annual market capitalisation, as show in equation 7:

$$\text{Ln}\left(\text{Average Market Capitalisation}_{i,t}\right) = \text{Ln}\left(\frac{\text{Daily Market Capitalisation}_{i,t}}{250}\right) \quad \text{[Eqn 7]}$$

Furthermore, as stocks of leveraged companies are often more volatile than those of less leveraged firms, leverage measured by the natural logarithm of the ratio of long-term liabilities to total assets was included as estimated in equation 8:

$$\text{Ln}\left(\text{Leverage}_{i,t}\right) = \text{Ln}\left(\frac{\text{Long term debt}_{i,t}}{\text{Total assets}_{i,t}}\right) \quad \text{[Eqn 8]}$$

Methodology

Event study

Changes in stock volatility and liquidity subsequent to the event date were examined using both univariate and regression analysis under the event study methodology in line with several previous studies including Leuz and Verrechia (2000), Fernandes and Ferreira (2008) and Dodd (2011). In addition, this methodology was appropriate because it observes the behaviour of stock liquidity and volatility around an event date and mitigates the possibility that some other unobserved variable is responsible for the cross-sectional differences in liquidity and volatility proxies (Leuz & Verrecchia 2000).

Univariate analysis

Earlier studies employed shorter event window periods, but it might be misleading to make inferences from changes over a short period as it might eclipse the probable variations over a longer event window period. As such, for a univariate analysis, this study examined changes in stock liquidity and volatility of shares around an event date using both short- and long-event window periods, as follows: 90 days (-90 days, + 90 days), 1 year (-1 year, +1 year) and 3 years (-3 years, + 3 years). In this study, it was assumed there were 250 trading days in a year, and hence 250 observations per year were summed and then divided by 250 to obtain an annual mean for each stock liquidity and volatility measure and control variable.

After computing stock liquidity and volatility measures in the respective event window period, the paired difference between the periods before and after an event date for each stock were estimated as per equation 9, where D_i refers to the paired difference in stock liquidity and volatility between the periods after and before an event date for each stock *i*:

$$D_i = \text{After}_{\text{LIQ/VOLi,t}} - \text{Before}_{\text{LIQ/VOLi,t}} \quad \text{[Eqn 9]}$$

The mean and median difference (after – before) was expected to be positive (after – before > 0) in the case of liquidity, negative (after – before < 0) in the case of volatility or there could be no change (after – before ≈ 0). As a decline in Amihud (2002) illiquidity is interpreted as an increase in stock liquidity, it was expected that the mean and median paired difference was negative (after – before < 0).

In similar empirical studies, see for example Fernandes and Ferreira (2008), Dodd (2011) and Bris et al. (2012), paired *t*-test for mean differences and Wilcoxon signed-rank test for median differences were used to examine the statistical difference between the two periods. The one-tailed hypothesis $H_0 = \mu \leq 0$ $H_1 > 0$, was tested to investigate whether the mean difference (μ = the paired mean difference [after – before]) in stock liquidity and volatility was statistically significant. On the other hand, a one-tailed Wilcoxon signed-rank test on the median differences (M_D = the paired median difference [after – before]) in stock liquidity and volatility was conducted by testing the following hypothesis: H_0: $M_D \leq 0$; H_1: $M_D > 0$.

In both tests, the *p*-value generated from the Wilcoxon signed-rank test and *t*-test for mean differences was used in assessing whether the median and mean differences, respectively, were statistically different from zero. These tests were performed at the following significance levels: 10%, 5% and 1%, and if the null hypothesis (H_0)was rejected at all significance levels it suggested that internationalisation resulted in an increase in stock liquidity and volatility after the event date. Conversely, failure to reject the null hypothesis suggested that internationalisation resulted in a decline or no change in share liquidity and volatility after the event date.

The preliminary assessment, however, may not fully reflect the actual changes in domestic stock liquidity and volatility, as it was established in previous studies by Halling et al. (2008), Berkman and Nguyen (2010) and Dodd (2011) that firm traits tend to influence changes in stock liquidity and volatility after the event date. Therefore, the next section details how firm-specific variables (in their natural logarithm) were incorporated into the analysis.

Regression analysis

The incorporation of the firm-specific variables into the analysis results in a dataset that uses both time series and cross-sectional elements, which is referred to as panel data. Two classes of panel approaches are broadly employed in financial empirical studies: fixed effects and random effects, which are estimated using either a balanced or an unbalanced panel. A balanced panel, as used here, has the same number of time-series observations for each cross-sectional unit, whereas an unbalanced panel has some cross-sectional elements with fewer observations or observations at different times to others (Brooks 2008).

The fixed effects model has different intercept terms for each entity and these intercepts are constant over time – with the relationships between the explanatory and explained variables assumed to be the same both cross-sectionally and temporally. In contrast, a random effects model proposes different intercept terms for each entity and again these intercepts are constant over time, with relationships between explanatory and explained variables assumed to be the same both cross-sectionally and temporally (Brooks 2008).

Prior to estimation of the fixed and random effects models, the dependent (liquidity and volatility proxies) and independent variables (firm-specific variables) were winsorised in the bottom and top 5% to remove outliers, which could have caused a disproportionate influence on regression results (see Berkman & Nguyen 2010; Bris et al. 2012). Then, the log-linear regressions were estimated using a fixed effects model (equations 10 and 11) and a random effects model (equations 12 and 13):

$$\begin{aligned}\text{Ln}(\text{LIQ}_{i,t}) = {} & \alpha + \beta_1 \text{FP}_{i,t} + \beta_2 \text{Ln}\left(\text{SIZE}_{i,t}\right) \\ & + \beta_3 \text{Ln}(\text{STDEV}_{i,t}) + \mu_i + v_{it}\end{aligned} \quad \text{[Eqn 10]}$$

$$\begin{aligned}\text{Ln}(\text{VOL}_{i,t}) = {} & \alpha + \beta_1 \text{FP}_{i,t} + \beta_2 \text{Ln}(\text{SIZE}_{i,t}) \\ & + \beta_3 \text{Ln}(\text{LEV}_{i,t}) + \beta_4 \text{Ln}(\text{TV}_{i,t}) + \mu_i + v_{it}\end{aligned} \quad \text{[Eqn 11]}$$

where μ_i is the firm-specific fixed effects, v_{it} is the idiosyncratic disturbance term. $\text{SIZE}_{i,t}$, $\text{LEV}_{i,t}$, $\text{STDEV}_{i,t}$ and TV_{it} denote the firm's size, leverage and standard deviation of close-to-close returns and trading volume in year *t*, respectively:

$$\begin{aligned}\text{Ln}(\text{LIQ}_{i,t}) = {} & \alpha + \beta_1 \text{FP}_{i,t} + \beta_2 \text{Ln}\left(\text{SIZE}_{i,t}\right) \\ & + \beta_3 \text{Ln}(\text{STDEV}_{i,t}) + \left(\mu + \epsilon_{it}\right)\end{aligned} \quad \text{[Eqn 12]}$$

$$\begin{aligned}\text{Ln}(\text{VOL}_{i,t}) = {} & \alpha + \beta_1 \text{FP}_{i,t} + \beta_2 \text{Ln}(\text{SIZE}_{i,t}) \\ & + \beta_3 \text{Ln}(\text{LEV}_{i,t}) + \beta_4 \text{Ln}(\text{TV}_{i,t}) + \left(\mu + \epsilon_{it}\right)\end{aligned} \quad \text{[Eqn 13]}$$

where $\mu_i \sim \text{i.i.d}\left(0, \sigma_\mu^2\right)$ is the unobserved random effect that varies across firms, but not over time and $\epsilon_{it} \sim \text{i.i.d}\left(0, \sigma_\epsilon^2\right)$ is the idiosyncratic error term.

It is often unclear which model is the best fit because of their inherent differences, and so, in line with empirical studies of this nature, Hausman's (1978) test was used to select the most appropriate model for explaining cross-sectional variation in share liquidity and volatility (see Silva & Chavez 2008; Dodd 2011; Bris et al. 2012). The best-fit model applies a null hypothesis that the random effects estimator is efficient and consistent versus fixed effects is inefficient. A $p < 0.05$ was taken as evidence that the random effects estimator was inefficient and inconsistent and hence the null hypothesis was rejected in favour of the fixed effects model. Of course, a fixed effects model cannot be used to estimate time-invariant causes of the dependent variable, which means that when time-invariant causes are included in the analysis, the random effects model will be used (Brooks 2008).

The sustainability of any liquidity and/or volatility changes may have been eclipsed by only comparing the average changes in stock liquidity and volatility in the period before and after an event date. Hence, following Halling et al. (2008), Berkman and Nguyen (2010) and Dodd (2011), the study also traced the year-by-year evolution of domestic stock liquidity and volatility, 3 years before and 3 years after internationalisation – as shown in equations 14 and 15:

$$\begin{aligned}\text{Ln}(\text{LIQ}_{i,t}) = {} & \alpha + \beta_1 \gamma_{i,t} + \beta_2 \text{Ln}(\text{SIZE}_{i,t}) \\ & + \beta_3 \text{Ln}(\text{STDEV}_{i,t}) + \lambda_t + v_{it}\end{aligned} \quad \text{[Eqn 14]}$$

$$\text{Ln}(\text{VOL}_{i,t}) = \alpha + \beta_1\gamma_{i,t} + \beta_2\text{Ln}\left(\text{SIZE}_{i,t}\right) + \beta_3\text{Ln}\left(\text{LEV}_{i,t}\right) + \beta_4\text{Ln}(\text{TV}_{i,t}) + \lambda_t + v_{it} \quad \text{[Eqn 15]}$$

where γ_t = a series of year dummy variables for each of the years surrounding the event date, λ_t = a time-varying intercept that captured all the firm-specific variables that affected stock liquidity and volatility in year *t* and v_{it} = the idiosyncratic disturbance term.

The slope coefficient of primary interest in equations 14 and 15 was the estimated year dummy variable (γ_t) relative to the event date, which indicated evolution of stock liquidity and volatility prior, during, and subsequent to the event date. If the year dummy slope coefficients after the event date were significantly increasing in magnitude relative to the previous years, it was interpreted as an increase in stock liquidity and volatility. In addition, a significant year dummy slope coefficient in the third year after the event date suggested that changes in stock liquidity and volatility were sustainable or endured. Insignificant year dummy slope coefficients in the third year after the event date suggested that changes were transitory or short lived.

The model selected by the Hausman (1978) test was corrected for heteroscedasticity and autocorrelation. The presence of heteroscedasticity and autocorrelation suggests estimators will no longer be best linear unbiased estimators (Brooks 2008). For that reason, the standard errors become inconsistent and biased, which has the effect of overstating *t*-values associated with any hypothesis and confidence intervals based upon the *t*-values. In light of the potential problems of heteroscedasticity and autocorrelation in the panel dataset highlighted above, the Newey and West (1987) test was used such that the estimated standard errors became heteroscedasticity and autocorrelation consistent (HAC) following Levine and Schmukler (2006) and Bris et al. (2012). Subsequently, each estimated slope coefficient (β_i) was tested for significance. If the null hypothesis that $\beta_i = 0$ was rejected, it implied the variable significantly explained changes in domestic stock liquidity and volatility after the event date.

Matched sample design

To investigate whether internationalised shareholders' equity had higher liquidity and lower volatility compared with purely domestic shares, the approach of Berkman and Nguyen (2010) and Dodd (2011) was followed. This comparison used univariate and regression analysis for a sample period of 3 years subsequent to the event date (dictated by data availability).

Univariate analysis

As a preliminary step, the paired difference between liquidity and volatility of purely domestic and internationalised stocks was estimated:

$$\text{Paired Difference}_{i,t} = \text{Internationalised}\left(i,t\right)_{\text{VOL/LIQ}} - \text{Purely Domestic}\left(i,t\right)_{\text{VOL/LIQ}} \quad \text{[Eqn 16]}$$

Where Internationlised $(i, t)_{VOL/LIQ}$ is volatility and liquidity of an internationalised stock *i* in year *t* and Purely Domestic $(i, t)_{VOL/LIQ}$ is volatility and liquidity of a purely domestic stock *i* in year *t*.

The paired *t*-test and Wilcoxon signed-rank test were then used to test for the statistical differences in means and medians, respectively, in liquidity and volatility of internationalised and purely domestic shares. In this case, rejection of the null hypothesis suggested that internationalised shares had significantly higher median and mean liquidity and volatility relative to purely domestic stocks. Alternatively, failure to reject the null hypothesis suggested there was no statistical difference between the median and mean liquidity and volatility of internationalised and purely domestic stocks.

Regression analysis

A firm was described as being either purely domestic or internationalised at any given time, and because this international dummy variable was time-invariant, the random effects model was used to estimate equations 17 and 18:

$$\text{Ln}(\text{LIQ}_{i,t}) = \alpha + \beta_1\text{INT}_{i,t} + \beta_2\text{Ln}(\text{SIZE}_{i,t}) + \beta_3\text{Ln}(\text{STDEV}_{i,t}) + \left(\mu + \epsilon_{it}\right) \quad \text{[Eqn 17]}$$

$$\text{Ln}(\text{VOL}_{i,t}) = \alpha + \beta_1\text{INT}_{i,t} + \beta_2\text{Ln}(\text{SIZE}_{i,t}) + \beta_3\text{Ln}(\text{LEV}_{i,t}) + \beta_4\text{Ln}(\text{TV}_{i,t}) + \left(\mu + \epsilon_{it}\right) \quad \text{[Eqn 18]}$$

where INT_t denoted the dummy variable that takes the value of 1 for internationalised stocks and 0 for purely domestic stocks, and other explanatory and explained variables are as those defined in equations 12 and 13. Inferences were based on HAC standard errors.

Results

Event study: Univariate analysis

Table 1 presents results of *t*-test for mean differences and Wilcoxon signed-rank tests for median differences between the period prior and subsequent to the event date. Table 2 considers the period following the event date in order to determine if any differences in liquidity and/or volatility of internationalised stocks are seen as being significant when compared with a matched sample of purely domestic stocks. This comparison ascertained whether there could be prospective value benefits derived from internationalisation of shareholders' equity via the liquidity and volatility routes *vis-à-vis* maintaining a primary listing on the JSE.

Panels A–C of Table 1 indicate that the increase in mean and median stock liquidity was significant only in the 3-year event window, with the exception of Amihud (2002) illiquidity that declined significantly in the 1-year event window period. That implies that there was no statistical difference in share liquidity between the pre- and post-internationalisation periods within a relatively shorter event window of 90 days and 1 year around an event date. Similar results were evidenced in the changes in stock volatility,

TABLE 1: Changes in liquidity and volatility around event date – Unmatched sample.

Variables	Panel A		Panel B		Panel C	
	90-day event window		1-year event window		3-year event window	
	Mean difference	Median difference	Mean difference	Median difference	Mean difference	Median difference
Turnover ratio	0.0250	0.0202	0.0044	0.0077	0.0110	0.0363*
	(0.5719)	(0.9655)	(0.8850)	(0.6067)	(0.5929)	(0.0839)
Trading volume	0.0312	0.0879	0.3521	0.2671	0.6917***	0.7573***
	(0.9518)	(0.9731)	(0.4126)	(0.3998)	(0.0068)	(0.0027)
Amihud illiquidity	-0.1089	-0.0136	-0.3818*	-0.1103*	-0.3525***	-0.2151***
	(0.6509)	(0.8323)	(0.0901)	(0.0894)	(0.0092)	(0.0000)
Close-to-close	0.0020	0.0179	-0.0372	-0.0252	-0.0297*	-0.0186*
	(0.9473)	(0.8211)	(0.5858)	(0.2423)	(0.0356)	(0.0372)
High-low ratio	0.0016	0.0014	-0.0001	-0.0010	-0.0015	-0.0015
	(0.6691)	(0.8738)	(0.9791)	(0.9425)	(0.5401)	(0.6494)

Note: *p*-values in parentheses are associated with the *t*-test for mean differences and Wilcoxon signed-rank test for median differences.
* and *** denote significance levels at 10% and 1%, respectively.

TABLE 2: Changes in liquidity and volatility after event date – Matched sample.

Variables	Mean difference	Median difference
Turnover ratio	6.2780***	0.2407***
	(0.0000)	(0.0000)
Trading volume	0.8540***	1.1951***
	(0.0002)	(0.0000)
Amihud (2002) illiquidity	-0.4680***	-0.5553***
	(0.0001)	(0.0000)
Close-to-close	-0.0804*	-0.0251
	(0.0751)	(0.1732)
High-low ratio	0.0061**	0.0067**
	(0.0461)	(0.0066)

Note: *p*-values in parentheses are associated with the *t*-test for mean differences and Wilcoxon signed-rank test for median differences.
*, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

where internationalised shares only experienced a significant (10%) decline in close-to-close volatility in the 3-year event window period, which provides weak evidence of decreasing volatility subsequent to internationalisation.

Table 2 shows that turnover ratio and trading volume of internationalised shareholders' equity was higher relative to purely domestic stocks, as seen by the positive mean and median difference between internationalised and purely domestic stocks. In addition, internationalised shares were less illiquid in juxtaposition to purely domestic stocks, as indicated by the negative mean and median paired difference in the Amihud (2002) illiquidity between internationalised and purely domestic shares. These mean and median differences were statistically significant at 1%, in line with expectations. This finding indicates that an improvement in the information environment surrounding internationalised shares, through heightened disclosure of firm-specific information and exposure to a larger pool of equity traders from foreign and domestic markets, could manifest in higher stock liquidity relative to stocks trading solely on their primary markets.

The high-low ratio of internationalised shares was higher relative to purely domestics stocks as suggested by the positive mean and median paired differences which were statistically significant at the 5% significance level. This suggests that intraday volatility of stocks listed and trading on foreign markets was relatively higher compared with a matched sample of purely domestic shares, which could be partially attributed to the differences in time zones between the host and home markets (Moulton & Wei 2009). Mean close-to-close volatility of internationalised stocks was lower relative to purely domestic shareholders' equity on the JSE, as indicated by negative mean paired differences which were statistically significant at the 10% significance level.

Tables 1 and 2 collectively show that listing and trading on foreign markets results in augmentation of stock liquidity using both unmatched and matched samples. The decline in volatility subsequent to internationalisation was sensitive to the proxy employed. That is, using a matched sample of internationalised stocks exhibited a higher high-low ratio, and yet under the matched sample the close-to-close volatility of purely domestic stocks was significantly higher than that of internationalised shares.

Regression analysis

A comparison of liquidity and volatility of stocks between the periods prior and subsequent the event date without controlling for factors that potentially influence liquidity and volatility, could return misleading results. Consequently, this section examines the impact, if any, of including firm traits. Domestic data only are presented in Table 3, and populated from equations 10 and 12, whereas the results of Table 4 are populated from equations 11 and 13.

In Table 3, Hausman's (1978) test yielded a *p*-value of 0.0651 and 0.0293 under the trading volume and Amihud (2002) illiquidity models, respectively. Hence, the alternative hypothesis that the fixed effects model is more efficient was accepted for these. Although variations in turnover ratio were better explained by the random effects model, it is important to note that similar conclusions are drawn regardless of the model selected. Slope coefficients had similar predictive signs and were statistically significant in close ranges in both the random and fixed models. Table 4 shows that the fixed effects model and random effects model best explained the variation in close-to-close volatility and high-low ratio, respectively.

As shown in Table 3, the foreign presence dummy variable in the trading volume and Amihud (2002) illiquidity model

TABLE 3: Liquidity changes around event date – Unmatched sample.

Variables	Turnover ratio		Trading volume		Amihud (2002) illiquidity	
	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects
Foreign presence	0.0150	0.0096	0.5584***	0.4300***	-0.2064*	-0.1785**
	(1.43)	(1.52)	(3.27)	(4.11)	(-1.73)	(-2.39)
Firm size	0.0187**	0.0271***	0.3719*	0.5105***	-0.2171**	-0.2508***
	(2.03)	(4.04)	(1.83)	(5.14)	(-2.04)	(-5.78)
Return volatility	0.1955***	0.1858***	2.0085***	1.7014***	-0.6543	-0.2844
	(4.80)	(3.41)	(4.32)	(4.06)	(-1.23)	(-0.96)
Intercept	-0.3334	-0.5172***	4.4705	0.2876	5.8371**	6.4422***
	(-1.63)	(-3.41)	(1.16)	(0.18)	(2.52)	(6.51)
Hausman's test *p*-value	0.6198 (Random effects)	-	0.0651 (Fixed effects)	-	0.0293 (Fixed effects)	-
R-squared	0.1664	0.1988	0.3735	0.4559	0.2270	0.1191

Note: Robust *t*-statistics values are represented in parentheses.
*, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

TABLE 4: Volatility changes around event date – Unmatched sample.

Variables	Close-to-close		High-low ratio	
	Fixed effects	Random effects	Fixed effects	Random effects
Foreign presence	-0.0594**	-0.0277*	0.0030*	0.0026
	(-2.86)	(-0.10)	(1.76)	(1.51)
Firm size	0.0199*	-0.0327***	-0.0006*	-0.0014*
	(1.82)	(-3.07)	(-1.76)	(-1.81)
Trading volume	0.0516***	0.0349***	0.0001	-0.0005
	(4.14)	(3.72)	(0.09)	(-0.51)
Leverage	-0.1737	-0.0015	0.0021	0.0096**
	(-1.44)	(-0.03)	(0.32)	(2.05)
Intercept	-0.7779**	0.6916***	0.0392	-0.0056
	(-2.37)	(3.32)	(1.21)	(-0.34)
Hausman's test *p*-value	0.0000 (Fixed effects)	-	0.2020 (Random effects)	-
R-squared	0.0830	0.0998	0.0179	0.1191

Note: Robust *t*-statistics values are represented in parentheses.
*, ** and ***'denote significance levels at 10%, 5% and 1%, respectively.

entered with a positive and negative sign, respectively, which suggested that domestic stock liquidity increased subsequent to internationalisation. A decline in Amihud illiquidity is tantamount to an increase in stock liquidity, and thus a negative foreign presence slope coefficient in the Amihud illiquidity model showed an increase in liquidity of internationalised shares following the event date. The foreign presence dummy variable was statistically significant at the 1% and 10% significance levels in the trading volume and Amihud illiquidity models, respectively. That is, subsequent to internationalisation there was an increase in liquidity of stockholder equity, as can be expected. These findings concur with the hypothesis that stock liquidity increases after admission to trade in foreign exchanges. This is because a firm becomes more visible and exposed to a wider spectrum of potential investors, resulting in a surge in stock liquidity. Moreover, these results are robust to changes in firm traits, echoing findings in previous studies by Leuz and Verrecchia (2000), Halling et al. (2008), Hedge et al. (2010) and Dodd (2011).

Turning to firm traits, the results suggest that an increase in firm size results in an increase in trading volume and turnover ratio, as suggested by the positive firm size slope coefficient in both models. The firm size slope coefficient entered significantly at the 1% and 10% significance levels in the turnover ratio and trading volume, respectively. Similarly, it was evidenced that there was a positive relationship between firm size and Amihud (2002) illiquidity, since the firm size slope coefficient entered with a negative sign and significantly at the 5% significance level. In line with expectations, it was evidenced that return volatility had a positive relationship with turnover ratio and trading volume, as indicated by the positive slope coefficients that were statistically significant at the 1% significance level.

Table 4 shows there was a decline in close-to-close volatility after the event date, as indicated by a negative slope coefficient on the foreign presence dummy variable, which entered significantly at the 5% significance level. This finding concurs with theoretical expectations that policies which enhance visibility and exposure of firm-specific information result in the reduction of information asymmetry which should manifest in lower stock volatility (see Anderson et al. 2005). In contrast, the high–low ratio coefficients were statistically insignificant, which agree with the findings from the univariate analysis where changes in high–low ratio were also insignificant.

The firm-level variables show that firm size and trading volume related differently to close-to-close volatility and the high-low ratio. More specifically, the positive trading volume and firm-size slope coefficients on the close-to-close model suggested that an increase in firm size and trading volume

resulted in an increase in close-to-close volatility – and the opposite was true for high-low ratio. The results in the close-to-close model were consistent with theoretical expectations, as suggested by Choi et al. (2012) who contended that there is a positive relationship between trading volume and volatility.

The second part of the 'Regression analysis' section considers a matched sample design in order to determine if changes are unique to the internationalised sample, or if they are also seen across the control group. Table 5 is based on the estimated log-linear regressions depicted in equations 17 and 18, where the random effects model is the best-fit as the international dummy variable is time-invariant (Clark & Linzer 2015).

After introduction of firm-specific variables, there was no statistically significant difference in the Amihud (2002) illiquidity and trading volume between internationalised stocks and purely domestic stocks. Table 5 shows that only turnover ratio of internationalised stocks was higher than purely domestic stockholders' equity, as suggested by the slope coefficient on the internationalisation dummy variable that entered with a positive sign at the 1% level. The firm-size slope coefficient entered with a negative sign and was statistically significant (1%) in the trading volume and Amihud illiquidity models. This suggested that as internationalised firms became larger, their trading volume and Amihud illiquidity became lower than that of purely domestic firms. In addition, the return volatility slope coefficient entered with a negative sign and was significant in the turnover ratio (5%) and trading volume models (10%), respectively. This implies that as return volatility of internationalised firms increased, their trading volume and turnover ratios became lower relative to purely domestic firms.

TABLE 5a: Domestic versus internationalised stocks – Matched sample.

Variables	Liquidity measures comparison		
	Turnover ratio	Trading volume	Amihud (2002) illiquidity
	Random effects	Random effects	Random effects
Internationalisation dummy variable	6.2427***	0.4015	-0.1961
	(5.76)	(1.54)	(-1.59)
Firm size	-0.1139	-0.3400***	-0.1694***
	(-0.95)	(-3.91)	(-4.63)
Return volatility	-0.4858*	-0.8091**	0.7554***
	(-1.30)	(-2.17)	(3.61)
Intercept	2.7944	5.2857***	4.1939***
	(1.05)	(2.72)	(4.91)
R-squared	0.2915	0.3714	0.3243

TABLE 5b: Domestic versus internationalised stocks – Matched sample.

Variables	Volatility measures comparison	
	Close-to-close	High-low ratio
	Random effects	Random effects
Int. dummy variable	-0.0185	0.0011
	(-0.37)	(0.48)
Firm size	-0.0363**	-0.0003
	(-2.60)	(-0.39)
Trading volume	-0.0478***	0.0044***
	(-3.51)	(5.58)
Leverage	-0.05855	0.0043**
	(-0.80)	(2.04)
Intercept	1.8687***	-0.2333
	(6.70)	(-1.51)
R-squared	0.1587	0.1874

Note: Robust *t*-statistics values are represented in parentheses.
*, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

After the introduction of firm-specific traits, the difference between the volatility of internationalised and purely domestic stocks became statistically insignificant at all significance levels in both the close-to-close and high-low ratio models. Therefore, after controlling for firm-specific factors, it can be reasoned there is no statistical difference between volatility of shares trading solely on the JSE and those that trade on secondary and primary markets simultaneously.

Sustainability of changes in stock liquidity and volatility around an event date

Table 6 shows the estimated log-linear models presented in equations 14 and 15. Year 0 is the year of internationalisation, Year -1 (+1) is the year before (after) internationalisation, and Year -2 (+ 2) is the year 2 years before (after) internationalisation. Unlike Tables 3 and 4, the results in Table 6 show whether changes in liquidity and volatility around an event date are transitory or permanent, after controlling for firm-specific factors that could influence changes in liquidity and volatility around an event date.

The gains in liquidity at the event date (Year 0), as measured by turnover ratio, were relinquished in the years following international listing as the magnitude of the year dummy slope coefficient declined in size and became statistically insignificant in subsequent years. In contrast, the size of the year dummy variable slope coefficient in the trading volume model increased in the subsequent years relative to the event date, and remained statistically significant at the 5% level 3 years after the event year (Year 0). In agreement with this, the magnitude of dummy variable slope coefficients in the Amihud (2002) illiquidity model became increasingly smaller following the event year, and significant at the 10% level, 3 years post-event. Collectively, with the exception of turnover ratio, these liquidity measures suggest there is some evidence that increases in stock liquidity of JSE-domiciled shares after internationalisation, are sustainable or permanent.

Close-to-close volatility decreased in the event year, with this decline becoming more pronounced in subsequent years. High-low also declined in the event year (Year 0), but this decline was eroded in Year 2 as the magnitude of the slope coefficient was larger and statistically insignificant in the subsequent years. Overall, as the two volatility measures reach different conclusions, there is inconclusive evidence pointing to whether any decline in volatility was sustainable or transitory subsequent to admission to trade in foreign markets.

Conclusion

The internationalisation of stockholders' equity is theoretically associated with numerous benefits which stem from heightened information disclosure and the consequent decline

TABLE 6: Evolution of domestic stock liquidity and volatility around event date.

Measure	Years relative to event date						
	-3	-2	-1	0	+1	+2	+3
Panel A: Liquidity							
Turnover ratio	-0.1757	-0.0132	0.0896	0.093**	0.0212*	-0.004	0.0012
	(-1.48)	(-1.42)	(0.70)	(2.72)	(1.91)	(-0.37)	(0.10)
Trading volume	-0.602***	-0.259**	0.0609	0.077***	0.3171**	0.1376	0.26**
	(-3.61)	(-2.61)	(0.55)	(3.86)	(2.56)	(1.44)	(2.04)
Amihud (2002) illiquidity	0.2027	0.0762	0.0209	-0.012**	-0.0852*	-0.088	-0.11*
	(1.50)	(0.72)	(0.26)	(-2.43)	(-1.88)	(-1.33)	(-1.81)
Panel B: Volatility							
Close-to-close	0.0314	0.013	0.0295	-0.013*	-0.0210*	-0.0133	-0.04**
	(1.23)	(0.81)	(1.31)	(-1.76)	(-2.14)	(-0.77)	(-2.52)
High-low ratio	-0.0035	-0.002	0.0011	-0.0002*	-0.0003	0.003**	0.001
	(-1.52)	(-1.46)	(0.64)	(-1.83)	(-0.18)	(2.09)	(0.39)

Note: Robust *t*-statistics values are represented in parentheses.
*, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

in asymmetric information surrounding a firm. In this article, the focus is narrowed to the impact of internationalisation on liquidity and volatility of stocks, using a sample of shares domiciled on the JSE that cross traded and cross listed on various exchanges between 1990–2014. The economic consequences from this study are relevant to corporate financial managers as well as market participants in South Africa.

Our results suggest that firms which listed and traded on foreign exchanges experienced a surge in stock liquidity compared with the period prior to the event date. This increase in liquidity was also noted in our regression analysis, as measured by the Amihud (2002) illiquidity ratio and trading volume. Initial analysis suggested that this liquidity effect was more than a temporary phenomenon. Though the univariate analysis suggested that internationalised stocks exhibited significantly higher stock liquidity relative to a matched sample of purely domestic shares, after introduction of firm-specific factors it was only the turnover ratio of internationalised shareholders' equity which was relatively higher. This suggests that internationalised stocks failed to exhibit a clear-cut liquidity advantage over purely domestic shares; highlighting the importance of considering such a comparison when undertaking research in this area. When volatility, as measured by standard deviation of close-to-close returns, is considered too, it suggested that internationalised shares domiciled on the JSE exhibited lower volatility subsequent to the event date – albeit this was short lived. However, there was no statistically significant difference between the stock volatility of a matched sample of purely domestic stocks and internationalised shares domiciled on the JSE. The choice of proxy for both liquidity and volatility was clearly important, for if we had simply reported trading volume and Amihud illiquidity as a measure of liquidity, we could have reported a sustained liquidity increase. While some studies focus on a single measure of liquidity, we report three measures of liquidity, and as only one shows this change, we are more cautious in our conclusions and recommendations.

These inconclusive results cast doubt on the hypothesis that internationalisation of stockholders' equity leads to an increase in liquidity and a decline in volatility. Consequently, our findings suggest that South African firms may be choosing to internationalise their stocks for other reasons – perhaps for signalling or legal-bonding reasons. If their reason for this move into an international space was based on liquidity and/or volatility benefits, our results indicate that internationalisation of stocks appears not to guarantee lower cost of capital via the liquidity and volatility routes.

Lastly, we provide avenues for future research, as an extension to this article. Firstly, this article has only investigated changes in stock liquidity and volatility from the perspective of firms domiciled on the JSE which list and trade on foreign markets. It would be interesting to investigate whether international firms which cross list on the JSE exhibit an increase in liquidity and/or decline in volatility. Secondly, the findings and conclusions are shown to be sensitive to the proxies used, and thus future studies should employ alternative measures of liquidity and volatility and determine which measure is the 'best'. Importantly, the results of this study indicate that liquidity and volatility reasons for internationalisation by South African domiciled firms are not substantial, and so research into the primary reasons for such decisions by corporate managers is warranted.

Acknowledgements

Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

This work was developed from K.J.C.'s Master's thesis where K.M. acted as the supervisor. The subsequent paper version of the dissertation was written up together, with each author taking it in turn to work on reformatting the dissertation to a journal paper format. Final editing and corresponding was done by K.M.

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