The price of microstructure risk on emerging stock markets: towards an integration of African financial markets

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Abstract: African stock markets have particular characteristics, chiefly the extreme volatility of their returns, which would imply a significant risk premium. Very few studies attempted to investigate the existence of this risk premium for some return determinants on these markets. The purpose of this article is to evaluate the price of the microstructure risk on some selected African emerging stock markets, including JSE, NSE and BRVM. The data used is from these stock markets databases and ranges from 2000 to 2014. Generalised least square and generalised estimating equations methods are used at the last step of a modified version of Fama and Macbeth's (1973) sequential estimation technique, on a set of portfolio formed based on two different strategies. The results show that microstructure risk is not significantly priced on individual stock markets. However, it is better priced when portfolios are constituted with stocks of several financial markets. Indeed, except the liquidity, all considered microstructure risk factors are significantly and consistently priced. This highlights the fact that the risk premium is more attractive when markets are integrated. The study points out the need for the globalisation of African stock markets and a necessity to facilitate information flow.

Keywords: emerging stock markets; international portfolio management; microstructure risk.

JEL codes: G11, G12, G15.

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1 Introduction

Risk has been studied widely in the financial literature since Markowitz (1952), and it has emerged as one of the major factors that should be taken into account in the valuation of a financial asset. The predictability of equity returns and the associated risk has been considered one of the most important issues in asset management for many years, raising some controversies among scholars in the financial literature (Georgiou et al., 2019). Numerous theoretical models, including the asset-pricing model of Sharpe (1964), the arbitrage model of Ross (1976), and the three-factor model of Fama and French (1993), consider various aspects of the risk in the valuation of a financial asset. Beyond these risk factors, although slightly neglected in the literature, the risk related to the microstructure of the financial market is among the most important in the context of emerging markets. Microstructure refers to the ways by which the trading processes[1] can affect stock price and transactions costs (Naes and Skjeltorp, 2006). In other words, the concept of microstructure refers to factors of the 'small structure' of a financial market that are specific to its internal functioning, unlike variables related to the market environment. Its importance is significant because it has an impact on market efficiency, asset values, liquidity, transparency, and transaction costs (Asmar and Zamri, 2011). According to Madhavan (2000), the importance of market microstructure can be confirmed at four levels: price discovery, market structure and design, transparency and other features of finance. Microstructural risk thus appears as the risk associated to unfavourable changes in the factors of the financial-market structure.

The number of studies taking into account financial-market microstructure in the valuation of financial assets is small but growing. Some were conducted to test whether the risks associated with microstructure variables are individually remunerated, particularly in the US capital market. Although it is difficult to reject the hypothesis that microstructure risk is remunerated for some variables in this market, the literature on other markets (developed or emerging) indicates that it is not possible to draw a conclusion. In this study, we focus our attention on the special case of financial markets in sub-Saharan Africa, which are generally considered to be very narrow, illiquid, and with irregular and infrequent transactions. They are regarded as the worst performing in terms of number of stock markets, number of securities, efficiency, liquidity, volume, frequency, speed, value, and number of transactions (Avoutou, 2018).

Nevertheless, African stock markets have experienced a remarkable evolution in recent decades, and their effects are often underestimated or simply ignored. However, their growth is surprising. Many African countries have experienced substantial improvements regarding the development of their stock markets and this is even true when one considers their effect on economic growth (Jalloh, 2016). The number of stock markets has almost doubled, and they currently represent more than 12% of the world's emerging markets. Between 2007 and 2009, their market capitalisation increased almost tenfold. This phenomenon can be observed particularly in sub-Saharan Africa, where financial markets grew considerably between 2002 and 2006. This is the case of Ghana, which recorded a growth rate of 1559% (Atiopu, 2007), and Nigeria, where local savings drained by the financial markets enabled the recapitalisation of the banking sector (Nkontchou, 2010). Moreover, the two largest stock exchanges on the African continent (JSE and NSE) are located in this region of the continent, and it is also in this region that we find the only successful experience of 'regionalisation' of stock exchanges (BRVM). These three financial markets thus offer an opportunity for inference, since no investor worthy of the name could afford the luxury of ignoring them (Hicham, 2008). According to Senbet and Otchere (2005), African stock market returns are higher (44% in 2003) than the one of world important global index like Morgan Stanley Capital International (MSCI) Global Europe Index (about 32%), the S&P index (26%) and Nikkei index (36%).

The aim of this study is therefore to verify if the microstructure risk is remunerated on these three stock markets, individually and globally. The data used are from the stock market databases, from 2000 to 2014, on the JSE, the NSE and the BRVM. Generalised least squares (GLS) and generalised estimating equation (GEE), used as estimation methods, allows controlling autocorrelation and heterogeneity.

The results of the study show that although microstructure is an important factor in asset pricing in most financial markets, the associated risk is not priced in sub-Saharan African emerging equity markets considered individually. The results are much better under the international portfolio construction hypothesis. In fact, we found that the prices of microstructure risk are more important when portfolios are formed with stocks from all considered stock markets. That means that this risk should be better priced when these stock markets are integrated.

This study differs from others in this field of study for at least three reasons. First, it takes into account several microstructural variables (frequency, value and number of transactions) that can provide significant information in the African context, and that is not taken into account in other studies on developed or emerging markets, which have focused on the effect of certain microstructural factors such as liquidity, transaction volume and information asymmetry. Second, this study considers the hypothesis of international portfolio construction, whereby the investor can operate in the African markets as it is a unique one. And third, this study also differs from the others in terms of methodology. Indeed, the heaviness of the standard technique of Fama and Macbeth

(1973) is reduced by the use of panel analysis, which eliminates the third and most difficult step, of the sequential estimation technique of Fama and Macbeth (1973). Moreover, the use of panels makes it possible to take into account the heterogeneity of individuals and the viability of the phenomenon in the individual and temporal dimensions.

This study is therefore of high interest to investors insofar as the results obtained would allow them to optimise their portfolio management policy. In fact, knowing which microstructure risks are the most important not only allows investors to better evaluate the assets which enter and exit their portfolios, but also provides information to optimise their investment decisions and make the market more efficient (it is known that African financial markets are very weak or not at all efficient). This study will also provide market authorities with guidelines for their policy of transparency, availability and free access to information for all, in order to reduce informational asymmetry and the holding of private information.

The rest of this article is organised into four major points. The first identifies the empirical works that deal with the issue of microstructure risk. The second presents the methodology adopted. The third highlights the results obtained and the fourth concludes and makes some recommendations.

2 Microstructure risk premium: literature review

2.1 Theoretical framework of the study

In the financial literature the problem of risk remains omnipresent. The theoretical base of this article goes back to the work of Knight (1921), who introduced for the first time this concept in financial decisions. Nevertheless, the modern mathematical formulation of the risk is attributed to Markowitz (1952). According to him, risk refers to all that deviates from the expectation. Thus, the standard deviation (or the sigma) appears as the adapted measurement of the risk, since it measures the deviation from the average. According to the capital assets pricing model (CAPM) of Sharpe (1964), this perception of risk is global because it does not consider the effect of risk diversification. According to Sharpe (1964), under perfect market conditions and in the absence of transaction costs, systematic risk (beta) appears as an adapted measurement of non-diversifiable risk on financial markets. This theory is criticised as far as the market is supposed to be the only factor for asset pricing and thus the only risk which is priced. It is in response to this criticism that Ross (1976), through the arbitrage pricing model (APT), asserted that the consideration of the market as the unique factor in CAPM, creates bias, since several risk factors can be accounted for in asset pricing. However, the non-identification of the latter represents the main weakness of this theoretical approach. Fama and French (1993) suggested that the risk associated to the size and value of a listed company should not be neglected. They define two new components that must be taken into account in asset pricing.

Similarly, several authors (Amihud and Mendelson, 1986; Amihud, 2002; Easley and O' Hara, 2003), suggest that other variables related to stock market microstructure should be taken into account. The illustration is provided in the clientele theory developed by Amihud and Mendelson (1986). Amihud and Mendelson (1886) show indeed that the price of a stock that offers indefinitely constant dividends, is given by the discounted value of these dividends subtracted from the expected costs of lack of liquidity. This result is obtained under the assumption that the investor reasons as if the investment periods were homogeneous. Assuming heterogeneous investment horizons, essentially in terms of duration, they show another implication that is summarised in the clientele theory. In this theory, one can notice that the investors are differentiated by the probability that they have to carry out the transaction at any moment of the supposed period of stock holding. As a result, each investor takes into account differently the impact of transaction costs on the expected return. Those who frequently trade will demand a higher return, compared to those with a low transaction frequency. In addition, a 'long-term investor' that can amortise transaction costs during this long holding period, will demand a lower return per period than a 'short-term investor' (Amihud and Mendelson, 1986). An investor who performs a small number of transactions will see the costs of illiquidity diminish over time. Consequently, the return will be higher for the investor with the highest transaction frequency, but he will also face transaction costs so high that this return will eventually become the lowest. In summary, the long-term investor will obviously have a low transactional frequency, which will reduce transaction costs (illiquidity cost) and allow him to achieve a higher return. This is why a share receives a premium in terms of return, relating to the lack of liquidity, the low trading frequency, the small size of the concerned company, etc. the application of this theory in various contexts led to mixed conclusions.

2.2 Empirical literature review

In the literature on financial markets, results of works related to microstructure risk compensation are generally grouped according to the variable studied, especially the effects of liquidity, trading activity, information asymmetry and size of the listed company.

2.2.1 The liquidity risk premium

Liquidity refers to the unlimited entry of traders in the market, which the consequences on their profit and on the price movement (Abraham, 2021). Concerning the literature on liquidity risk, Amihud and Mendelson (1986) and Amihud and Mendelson (1986), show that there is a decreasing relationship between liquidity and excess return. Thus, the most liquid stocks are the least profitable and the 'patient' investors ask a premium in compensation for the lack of liquidity of the stocks they hold. They consequently highlight the existence of a liquidity premium in the US financial market. Similarly, Acharya and Pedersen (2005) use another indicator of illiquidity (Amihud's illiquidity ratio) and show that liquidity and Illiquidity risk are significantly considered in the asset pricing on NYSE and AMEX from 1962 to 1995 (the corresponding monthly premium is about 4.6%). This is consistent with the results of Chan and Faff (2005), Bollar et al. (2008), Burhop and Gelman (2015) and Lesmond et al. (1999). Contrary to the previous results, Soosung and Chensheng (2005), find that it is difficult to conclude that there is a premium for liquidity risk on the British market between 1997 and 2004, regardless of the portfolio formation strategy.

On emerging markets, Hearn and Piesse (2009), show that for four African markets (Kenya, JSE, Morocco and Egypt), the premium associated to size and liquidity risk is negatively related to the price variation of financial assets. This is contrary to Hu (1997), who use the Fama and Macbeth's (1973) estimation technique on Tokyo Stock Exchange between 1975 and 1993 and found that stocks with a high turnover tend to have a lower expected return, proof that there is a certain liquidity premium. Huang and Ho (2020) discover that liquidity is important for asset pricing for stock listed on Chinese financial market. Pojanavatee (2020) also find that liquidity is an important factor for assets pricing in the Thailand Stock Exchange. Bhattacharya et al. (2020) find that for some specific business sectors (including finance, industry, utilities, telecommunications, and real estate); higher systematic risk also leads to higher expected return. Cakici and Zaremba (2021) find that the liquidity risk is slightly priced on 48 world countries, even though this risk premium is a function of firm size. Similarly, Chekili and Abaoub (2013) argue that the existence of the liquidity premium is not the only fact of the January effect.

Finally, it can be seen that on the American stock market, it is more obvious that liquidity is a priced factor, but when considering other markets, empirical results become less categorical. Moreover, it should be noted that liquidity or its lack is linked to information asymmetry, but the two are not identical, because if the illiquidity is caused by certain exogenous factors, the risk of information is the cause of a market efficiency dynamic (Nižinskas, 2009). Moreover, Easley et al. (2002) shows that both are linked.

2.2.2 The risk premium associated to information asymmetry

With respect to information asymmetry, Easley and O'Hara (2004) theoretically demonstrate that information risk should affect asset returns. Easley et al. (2002, 2005) provide empirical evidence of this impact and find from the Fama and French (1993) model that, a 10% increase in the probability of having an informed transaction (PIN) increases the expected annual return of about 2.5% on average. Easley and O'Hara (2004) interpret these results in the sense that information risk (information asymmetry) is well paid or taken into account by investors on the NYSE and the AMEX. Similarly, Wang (2007) shows, on the Taiwan Stock Exchange that information risk is a significant determinant of stock prices, since a 10% increase in the PIN leads to a 4% to 7% increase of the annual return of the shares. This result is reinforced when they find that the uninformed traders are rewarded for the information risk they take.

These results are in contradiction with those of Mohanram and Rajgolpal (2009), who demonstrate that the PIN is not a cross-sectional risk factor taken into account in the explanation of the stock expected returns. Fuller et al. (2010) find a similar result using only NASDAQ shares. These authors find, using Ross' (1976) asset pricing model, that the asymmetry of information measured by the PIN is the underpriced factor and that the latter does not even affect the increase of the excess return value. According to Hughes and Liu (2005) and Lambert et al. (2006), information risk should not be remunerated because a large number of operators proceed to diversification on the market.

2.2.3 The risk premium linked to trading activity

Concerning the trading activity, the only risk premium highlighted in literature is that related to trading volume. In this regard, we will talk of high-volume premium effect when the transactions on large volumes benefit from a risk. Thus, Gervars et al. (2001) conclude to the evidence of risk premium associated to this factor on the NYSE, when considering different information periodicity. Huang and Heian (2001) find the same result on both NYSE and AMEX. According to the latter, there is a portion of abnormal returns that is associated with the volume of transactions, although the latter decreases significantly when the holding period exceeds eight weeks. Similarly, Tang et al. (2013) and Gorder et al. (2014), find that on the Australian market, the stocks of large companies obtain a short-term premium for large transaction volumes. In contrast, Kaniel et al. (2012) studies this effect on developed and emerging countries. They find a high premium volume for most developed markets and only for some emerging stock markets. Singh et al. (2014), from a set of established portfolios, conclude that stocks with large trading volumes do not perform better. Thus, contrary to the results on developed markets, low trading volume portfolios lead to significant returns on the Chinese stock markets (Shanghai Stock Exchange and Shenzhen Stock Exchange). Zhou (2021) finds that option trading volume negatively predicts future stock returns. Gul and Ullah (2020) find that transaction cost and trading activity better explain asset pricing when they are considered together and not individually.

2.2.4 The risk premium related to the size effect of the listed company

As far as the size effect is concerned, the works of Fama and French (1993) show that small stocks (measured by market capitalisation) perform better than big stocks; therefore, there is a risk premium for the size effect. The results obtained in other markets are divergent. Bollen and Dempsey (2010) for instance shows that in the Australian market, stocks with smaller market capitalisation perform better than stocks with higher capitalisation. Similarly, Nawazish (2008) shows that on the Karachi Stock Exchange, there is a risk premium associated with the microstructural size effect. Unlike previous authors, Geert (1998), Molay (2002) and Lu (2005) find that enterprise size risk is not taken into account in the asset pricing.

Finally, empirical studies generally show that the conclusions on the pricing of risk associated to microstructure effects are divergent, insofar as they vary according to the financial market chosen and the microstructure variable used, putting forward the problem of specificity of financial markets, which outline the need for new verification, especially in Africa where studies are scare and where the literature remains very little provided on the topic.

3 Methodology and data

This section is dedicated to data source, the econometric model, estimation technique used.

3.1 Nature and source of data

The data used in this article are daily and obtained from the database of the three stock markets of our sample: Johannesburg Stock Exchange (JSE), Nigerian Stock Exchange (NSE) and 'Bourse Régionale des Valeurs Mobilières' (BRVM). As we said earlier, those financial markets are chosen because there are respectively the two first of the country and the only successful experience of the 'regionalisation' of a stock market in the word. Those information's consist essentially of three groups of information's from January 2000 to December 2014. The first batch informs about the trading activity, especially the volume, the value and the number of transactions, the number of trading days within the month and the stock price. The second group informs us about the amount of dividends received by the owners of each listed stock. Finally, the third set of information provides clarifications about the market information, including the different market index and market capitalisation. In addition, the data on risk-free rates (interbank rate) were obtained directly from the database provided by the various concerned central banks (Nigeria, South Africa and the Central Bank of West African States). As it is generally the case, daily data are converted into monthly information and this last is used for analysis.

3.2 Econometric model and portfolio formation

The theoretical model of this research is a panel adaptation form of the Ross (1976) APT. It can be presented as follows:

$$Excess\ Return_{it} = f\left(microstructure_{it}\right)$$

Algebraically we have:

$$R_{i,t} - R_{ft} = \alpha_0 + \sum_{s=1}^{m} \beta_i M_{i,t} + \varepsilon_{i,t} \tag{1}$$

With $i = 1.2, \ldots, N$ (the number of portfolios) and $t = 1.2, \ldots, T$ (the number of months). $R_{it} - R_f$, is the return of stock i (R_{it}) in excess of risk free rate. M is the microstructure variables, α_0 is the constant term and $\varepsilon_{i,t}$ is the error term.

Table 1 Breakdown of the study period into two sub-periods

Stock markets	*Period of study*	*Estimation period*	*Test period*
JSE	2000–2014 (15 years)	2000–2006 (7 years)	2007–2014 (8 years)
NSE	2000–2010 (11 years)	2000–2004 (5 years)	2005–2010 (6 years)
BRVM	2000–2014 (15 years)	2000–2006 (7 years)	2007–2014 (8 years)
IPM (*global*)	2000–2014 (15 years)	2000–2006 (7 years)	2007–2014 (8 years)

Note: International portfolio management represents the situation where the portfolios are formed with the stocks of the three stock markets simultaneously.

Source: Author from the data

Special attention is given to the studied time period in the methodology of Fama and Macbeth (1973). Indeed, the overall study period (between 2000 and 2014 for the JSE, NSE and IPM and from January 2000 to December 2010 for the BRVM) is considered as the estimation period. The above technique requires a decomposition of the time dimension into an estimation period and a test period. This disintegration into subsets makes the model more predictive, but also makes the results more meaningful. Therefore, in reference to the literature on this approach (Fama and Mcbeth, 1973; Dalgaard, 2009), the study period chosen, which is globally 15 years is subdivided into two sub-periods: a beta estimation period for each of the explanatory variables and a test period that will make it possible to estimate the sensitivity factors (gammas) to be used to explain the studied phenomenon. Table 1 shows the time division in each of the markets of the sample.

It can be seen that only the BRVM displays a situation different from the other markets. The first five years (from 2000 to 2004) are used to estimate the risk (the betas) and the six last years (from 2005 to 2010) to estimate the risk premiums (gammas) associated with the different microstructure factors. The characteristics of the new panels are as follows (Table 2).

Table 2 Characteristics of the panel for risk premium analysis

Financial markets	*Total number of stocks*	*Sample*	*Number of portfolio (i)*	*Number of stocks per portfolio*	*Time dimension (t, in months)*
JSE	402	208	16	13	96
NSE	223	140	14	10	96
BRVM	42	32	8	4	72
IPM	667	380	20	19	96

The temporal dimension has changed; it is not the overall studied period, but rather the test period, which is six years (72 months) everywhere else except on the BRVM where it is 8 years (96 months). The individual dimension of this panel consists of the portfolios that have been formed according to the risk measured (the stock value of systematic risk or beta) on the one hand and, on the other hand, according to the double allocation, from the risk-liquidity pair. The variables in the above model are presented below.

3.3 Variables of the study

Since the study concerns the role of risk premium in asset pricing, our dependent variable is the return in excess of the risk-free rate or the surplus return $(R_{it} - R_f)$. Overall, the explanatory variables used are grouped into three major groups: trading activity variables, the size of the listed stock and its liquidity. Asymmetric information cannot be captured because of the structure of African financial markets (market led by orders).

3.3.1 Trading activity variables associated to the microstructure

In microstructure literature, three main variables of trading activity have been studied in relation with asset pricing, but the only one that has been subject to a considerable number of theoretical and empirical studies is the number of trading stocks or the trading volume. We can associate the trading value (TV), trading number and trading frequency. It is important to mention that in the African context; only the first variable has been the subject of some work. The details on each of these variables are as follows:

- *Number of traded stock (NTS)* is the trading volume that measures the number of securities traded during a transaction. Several studies to account for the effect of this variable on asset pricing (Gervars et al., 2001, Lee and Rui, 2002; Huang and Heian, 2001).
- *The TV* as microstructure variable is the monetary value of the transaction. The information provided by this variable is different from that obtained with the transaction volume; because one can have a transaction of significant value based on a very small number of stocks and reciprocally. Very few studies (Kumar and Sing, 2009; Chordia et al., 2001) used this variable to take into account the effect of microstructure on asset pricing.

- *Number of transactions (NT)* provides the information about the number of times that there was a transaction (sale or purchase) on the relevant stock. This variable has been used by Harris (1987), Xue and Gencay (2008) and Kumar and Singh (2009) and the results obtained are inconclusive.
- *Number of trading days (NTD)* is the numbers of days in the month[2] where there is at least one transaction (buy or sell), that is the trading frequency on a stock. Baron et al., (2012) show that the increased transaction frequency is profitable for the company.

In addition to this microstructural effect associated with the trading activity, we can still distinguish the size effect of the company and the effect of liquidity.

3.3.2 Stock capitalisation (SC): the company size

It refers to the size of the company, which takes into account 'the size effect'. The latter assumes that the securities of large firms or large stock portfolios will benefit from a higher return. This effect is taken into account in this study by the stock market capitalisation. Nawazish (2008), Geert (1998), Molay (2002) and Lu (2005) use the same variable. According to Fama and French (1992, 1993), we expect a negative relationship with expected surplus return.

3.3.3 The liquidity (LIQ)

Several studies have referred to the bid-ask spread as an indicator for lack of liquidity, but in most emerging stock markets such as Africa, it is difficult to obtain the information needed for its determination. It is why, the Amihud illiquidity ratio, is used here to measure liquidity, as it was the case with Dalgaard (2009), Hikouatcha et al. (2016), who show that, compared to turnover, this indicator is able to better explain the expected return.

3.4 The simplified and modified estimation technique of Fama and Macbeth (1973)

Fama and Macbeth (1973) were the first to introduce the sequential estimation approach in the financial-market research area. They propose the most used method when considering risk in assets pricing models[3], because of its empirical results, and for its undeniable merits of simplicity and clarity (Pasquariello, 1999). This multistep econometric estimation in a very simplified way consists in considering as input variable of a step, the outputs of the previous step.[4] The method has three stages. The first step concerns the estimation of betas (factor loading), using the ordinary least square technique. In the second step, a cross-sectional analysis is carried out to estimate the gammas (risk prima factors) from the previously calculated betas, as input variables. Thirdly, one proceeds to the aggregation of gammas and tests of hypotheses. In fact, after estimation for each portfolio, they aggregate the results to the market by using a simple average value of the parameters and a Student test is used for validation of the hypothesis.

This procedure is not free from criticisms, especially with regards to the importance of the calculations to be performed in the third step and the number of studied variables. It is precisely for this reason that we propose as a solution to use the panel data at the second step, which allows to automatically combine the last two steps, while having estimators that are even more effective and less tedious. This solution may seem very simplistic, but it is really a major contribution for this estimation approach. The advantages of using panel data are many; among them we can consider the fact of controlling the heterogeneity of individuals and take into account the variability of the studied phenomenon between individuals and their evolution over time. This allows to go beyond literature, because only the individual dimension or cross-sectional analysis has always been used.

By applying this revised and corrected method to assess the risk premium on the financial markets of sub-Saharan Africa in general and particularly those of our sample, the two prescribed steps can be presented as follows:

First step is the estimation of the coefficients (beta) of the microstructure factors: the first regression that makes it possible to obtain the systematic risk factors (for each microstructure variable) is made for each portfolio *i* at time *t*, according to the model below:

$$R_{it} - R_{ft} = \alpha_0 + \beta_{1it} NTS_t + \beta_{2it} NT_t + \beta_{3it} NTD_t + \beta_{4it} TV_t + \beta_{5it} SC_t + \beta_{6it} LIQ_t + \varepsilon_{it} \quad (2)$$

With $t = 1, \ldots, 60$ for the BRVM and $t = 1, \ldots, 84$ for the other stock markets.

Estimates are made for each portfolio by OLS. For example, the data for the first month of year 2007, in the case of the JSE, are the estimated values of each of the previous parameters over the period between January 2000 and December 2006, and so on until the observation of December 2014, which are the parameters of the same model for the period from December 2007 to November 2014. The data thus obtained are used in a second model to obtain microstructure risk premiums.

The second step is the estimation of the risk premium model: all the parameters of the portfolios obtained in the first step are used in the following regression:

$$R_{i,t} - R_{ft} = \alpha_0 + \delta_1 \beta_{NTS_{i,t}} + \delta_2 \beta_{NT_{i,t}} + \delta_3 \beta_{NJD_{i,t}} + \delta_4 \beta_{TV_{i,t}} + \delta_5 \beta_{SC_{i,t}} + \delta_6 \beta_{LIQ_{i,t}} + \varepsilon_{i,t} \quad (3)$$

The parameters of this regression model are now risk premiums which explain the risk exposure of each microstructure factor. As a result, the portfolio with a high sensitivity to any one of the four factors should expect the highest return to pay for the additional risk to which it is exposed. This model will be estimated from GLS and GEE. The GLS methods are used because it allows the correction of autocorrelation and heteroscedasticity bias which may occur when carrying out the simple ordinary least square method. The GEE method has the advantage of using the richer correlation structure of robust standard errors.

4 Results and discussion

For each of the portfolio estimation and formation process, a significant coefficient represents the risk price (in terms of excess return), which compensates the risk taken by the investor who holds a stock with certain characteristics. Before showing the results, let us first present the global statistics concerning the studied variables.

Table 3 show for each of the six microstructure systematic variables and the excess return variable, the mean, the standard deviation (std. dev), the minimal and maximal value of the concerned systematic risk. Panel A, B, C and D are respectively summary information of BRVM, NSE, JSE and international management of portfolio (IMP).

From Table 3, on remarks that, no matter how portfolio are formed, BRVM is the only market where excess return value is negative. For NSE, JSE and IPM, the average value of excess return is at least equal to 10%. JSE is the stock market with the highest value of excess return follow by IPM and NSE. This is normal considering the fact that JSE is the first stock market in Africa. In addition, the second highest-risk premium value on IMP can be explained with diversification effect. Furthermore, liquidity is globally the microstructure variable with the highest value of systematic risk on average (at least 80% for IPM). The average value of systematic risk for the rest of microstructure variables varies from one stock market to another, but it is generally less than 1% with a mixture of positive and negative values as show by 'Min' and 'Max' column of Table 3. These systematic risk variables are those obtain at the first stage of Fama and Mcbeth (1973) estimation process, that is, the variables to be used at the second step in equation (3).

These descriptive statistics are not showing the direction of the relationship between microstructure risk and the excess return. It is why the correlation analysis is carried out on the same variables and the results are in Table 4. This Table 4 is an extract of the correlations matrix between the studied variables, for each stock market and for each of the portfolio building methods. Only the column showing the correlation between microstructure variables and excess return are presented here.

Once again, from Table 4, it appears that, the link between the microstructure risk variables and the excess return over the risk-free rate depends on the considered market and the variable. This implies that studied stock markets behave differently one another. With a few exceptions, the correlation value is globally less than 10%, meaning that the models do not suffer from a multicollinearity effect. Moreover, illiquidity variable which has the highest systematic risk value on average seem to be less significantly correlated to excess return. The problem with correlation analysis is that it does not give the value of risks prices; hence the need of regression analysis which results will give the value of microstructure risks prices.

4.1 Microstructure risks prices on the JSE?

Table 5 presents the results of the estimation of equation (3) for JSE stock market data. The coefficient here represents risks prices or the value of risk premium, for both estimation methods (GLS and GEE) and portfolio assignment methods (that is liquidity-beta portfolio and beta portfolio).

It appears from Table 5 that the value of the constant term is positive and significant regardless of the method used to estimate and form portfolios. This stipulates that microstructure risks are not the only risk factors to consider, thus the price many others can be appreciated.

Table 3 Summary statistics of the excess return and the microstructure systematic risks variables for each studied stocks markets

		Double assignment				*Beta assignment*			
Variables	*Obs*	*Mean*	*Std. dev.*	*Min*	*Max*	*Mean*	*Std. dev.*	*Min*	*Max*
Panel A: summary statistics of systematic risk and excess return on BRVM									
Return	576	–0.0312	0.0660	–0.2620	0.2930	–0.0309	0.0739	–0.302	0.438
β_{NTS}	576	0.0019	0.0002	–0.0017	0.0172	–0.0688	0.0056	–0.0021	0.0015
β_{NT}	576	0.0018	0.0023	–0.1000	0.0488	0.0043	0.0162	–0.0197	0.0536
β_{NTD}	576	0.0016	0.0059	–0.0132	0.0192	0.0016	0.0052	–0.0108	0.0225
β_{TV}	576	0.0020	0.0362	–0.212	0.0688	0.0088	0.0343	–0.135	0.0994
B_{SC}	576	–0.0061	0.0225	–0.0428	0.1250	–0.0115	0.0171	–0.0630	0.0527
β_{LIQ}	576	1.2046	1.1863	0.0588	1.9354	1.0895	0.9728	0.2540	1.7276
Panel B: summary statistics of systematic risk and excess return on NSE									
Return	1,344	0.1020	0.2270	–0.3680	3.5260	0.1010	0.2250	–0.2510	4.2630
β_{NTS}	1,344	0.0017	0.0307	–0.0484	0.0324	–0.0083	0.0056	–0.0291	0.0371
β_{NT}	1,344	0.0082	0.1140	–0.4890	2.1870	0.0012	0.0039	–0.0271	0.0301
β_{NTD}	1,344	0.0068	0.0277	–0.0171	0.3510	–0.0013	0.0171	–0.1090	0.0976
β_{TV}	1,344	0.0365	0.0895	–0.414	0.4020	0.1220	0.4200	–0.9030	2.0580
B_{SC}	1,344	–0.0172	0.0551	–0.285	0.2160	–0.0769	0.2950	–1.4820	0.6250
β_{LIQ}	1,344	1.8900	2.2581	–0.0618	2.9923	2.9798	3.6852	–2.7570	4.6550
Panel C: summary statistics of systematic risk and excess return on JSE									
Return	1,536	0.1110	0.2280	–1.9520	4.5710	0.1090	0.2380	–2.0890	4.2920
β_{NTS}	1,536	–0.0003	0.0087	–0.1100	0.0438	–0.0004	0.0020	–0.0126	0.0045
β_{NT}	1,536	–0.0036	0.0163	–0.1040	0.0584	–0.0001	0.0015	–0.0173	0.0062
β_{NTD}	1,536	0.0011	0.0144	–0.0311	0.1170	0.0033	0.0153	–0.0624	0.1030
β_{TV}	1,536	0.0383	0.1430	–0.2610	0.5070	0.0068	0.1710	–0.4060	0.8620
B_{SC}	1,536	–0.0196	0.1020	–0.3920	0.1790	0.00340	0.1150	–0.5460	0.3790
β_{LIQ}	1,536	0.8739	0.6681	–0.9580	1.1373	2.8131	3.2629	–2.9567	4.2370
Panel D: summary statistics of systematic risk and excess return for IPM									
Return	1,920	0.105	0.195	–1.277	4.541	0.1050	0.1760	–1.1310	3.0580
β_{NTS}	1,920	–1.2410	0.2255	–1.3825	–1.1075	0.0028	0.0126	–0.0804	0.0749
β_{NT}	1,920	–0.0016	0.0176	–0.131	0.158	–0.0938	0.0166	–0.0083	0.0095
β_{NTD}	1,920	0.0055	0.0253	–0.0362	0.205	0.0022	0.0119	–0.0899	0.1050
β_{TV}	1,920	–0.0118	0.133	–0.597	0.304	–0.0105	0.1240	–0.6110	0.8010
B_{SC}	1,920	0.0126	0.0702	–0.181	0.253	0.0148	0.0705	–0.4120	0.3540
β_{LIQ}	1,920	0.8070	0.6800	–0.4782	1.1476	1.1880	2.0599	–2.1885	3.2650

Table 4 Correlation test analysis between excess return and microstructure risk variables

Markets	*BRVM*		*NSE*	
Port process	*Beta port*	*Double port*	*Beta port*	*Double port*
β_{NTS}	0.0120	0.0415	0.2900***	0.2870***
	(0.773)	(0.3210)	(0.0000)	(0.0000)
β_{NT}	–0.0985**	–0.0549	0.2730***	0.6370***
	(0.0181)	(0.1880)	(0.0000)	(0.0000)
β_{NTD}	0.0586	0.1020**	0.0755***	0.1650***
	(0.1600)	(0.0148)	(0.0056)	(0.0000)
β_{TV}	0.0718*	–0.0804*	–0.0720*	0.0145
	(0.0851)	(0.0538)	(0.0082)	(0.5960)
B_{SC}	–0.0705*	0.0769*	0.0661**	–0.0638**
	0.0907	(0.0650)	(0.0153)	(0.0193)
β_{LIQ}	–0.0912**	–0.0157	0.0229	–0.00180
	(0.0286)	(0.7070)	(0.4030)	(0.9480)
Markets	*JSE*		*IPM*	
Port process	*Beta port*	*Double port*	*Beta port*	*Double port*
β_{NTS}	0.0429*	0.0253	0.0701***	0.0170
	(0.0927)	(0.3220)	(0.0021)	(0.4570)
β_{NT}	0.0469*	0.0467*	–0.0314	0.0368
	(0.0663)	(0.0676)	(0.1690)	(0.1070)
β_{NTD}	0.1910***	0.0655**	0.2500***	0.0614***
	(0.0000)	(0.0102)	(0.0000)	(0.0071)
β_{TV}	–0.1510***	–0.1090***	–0.0418*	–0.0812***
	(0.0000)	(0.0000)	(0.0672)	(0.0004)
B_{SC}	0.2110***	0.0857***	0.0118	0.0766***
	(0.0000)	(0.0008)	(0.606)	(0.0008)
β_{LIQ}	–0.0296	–0.0607**	0.0054	–0.0443*
	(0.2460)	(0.0173)	(0.8140)	(0.0523)

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Concerning the microstructure variables, we realise that it is difficult to conclude that the related risk is priced. Indeed, only the risk associated to the number of trading stocks is negatively and significantly (at a 1% significance threshold) linked to excess returns for the two estimations and portfolio formation methods. Thus, a unit increase of the risk of to this microstructure factor lead to a decrease of the risk price, which does fit with the risk-return theory. Therefore, there is no risk premium for holding stock which is not regularly trade. Similarly, the 'number of transactions', the 'trading volume' and 'SC' have the same negative and significant effect on excess return when GEE is used as estimation method. When portfolios are formed only on the basis of stock systematic risk, 'trading volume' and 'SC' now have a positive and significant coefficient, meaning that there is a risk premium for holding stock with low 'trading volume' and 'SC'.

Table 5 Microstructure risks price on JSE

BRVM	*Beta-liquidity portfolio*		*Beta portfolio*	
Variables	*GLS*	*GEE*	*GLS*	*GEE*
β_{NTS}	–3.2120***	–3.9760***	–2.0410***	–1.9934**
	(0.0066)	*(0.0023)*	*(0.0064)*	*(0.0229)*
β_{NT}	0.6140	–0.1040	1.2866***	0.7175
	(0.2010)	*(0.8670)*	*(8.28e-07)*	*(0.172)*
β_{NTD}	0.0330	–3.0950**	–3.0160***	–1.236
	(0.9770)	*(0.0162)*	*(0.0000)*	*(0.3250)*
β_{TV}	–0.4860	–1.2960***	2.7900***	0.921***
	(0.1980)	*(0.0037)*	*(0.0000)*	*(0.0093)*
B_{SC}	–0.5050	–1.6510**	2.8320***	1.9230***
	(0.3650)	*(0.0134)*	*(0.0000)*	*(0.0006)*
β_{LIQ}	–0.00411**	–0.0074**	–0.0013	0.0036
	(0.0182)	*(0.0276)*	*(0.6680)*	*(0.9250)*
Constant	0.157***	0.0797**	0.0626***	0.0958***
	(0.0000)	*(0.0217)*	*(0.0000)*	*(0.0006)*
Observations	1,536	1,536	1,536	1,536
Number of portfolio	16	16	16	16

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Similarly, with illiquidity variable, the negative and significant sign obtained allows to conclude that there is a risk premium for the concerned microstructure variable. Unfortunately, the magnitude of the risk price is too small, and this is no longer significant when the portfolio formation method changes. In fact, when the portfolios are constituted according to the stock systematic risk (beta portfolio), the liquidity parameters record a non-significant value.

All the above results are robust to different specification of the estimated model. Indeed, Tables 9 and 10, show that the conclusions made above are globally stable to the exclusion of some variables, no matter the estimation and portfolio formation process. Table 9 presents the results when portfolio are double assigned (according to liquidity and systematic risk successively) for both GLS and GEE estimation methods, while Table 10 does the same when portfolios are formed only according to systematic risk. The results allow to conclude that changing specification does not affect the effect of microstructure risk on JSE.

Finally, it is difficult to conclude that microstructure risk factors are priced on JSE and this result is in accordance with the African context of low development of the financial market. This result also confirms several studies on the emerging stock markets. Similarly, Joher (2009) in the Malaysian market, Dalgaar (2009) in Denmark and Barend (2009) in South Africa, had already shown that liquidity risk is not considered on asset pricing. Lambert et al. (2006), justify this result by the fact that a large number of operators proceed to the diversification of these risks. Furthermore, these conclusions contradict the main empirical results on the US financial market and several developed markets as evidenced by Amihud and Mendelson (1986), Datar et al. (1998), Acharya and Pedersen (2005), Bollen et al. (2008), Chang et al. (2014) and Gervais et al. (2001).

4.2 Pricing of microstructure risk on NSE

The results obtained on the NSE data are provided in Table 6.

Table 6 The price of microstructure risk on NSE

BRVM	*Beta-liquidity portfolio*		*Beta portfolio*	
Variables	*GLS*	*GEE*	*GLS*	*GEE*
β_{NTS}	1.8554***	1.9504***	1.2350***	1.9140***
	(0.0002)	(1.91e-05)	*(0.0000)*	*(0.0000)*
β_{NT}	1.1920***	1.1880***	1.3209***	1.2574***
	(0.0000)	(0.0000)	*(0.0000)*	*(0.0000)*
β_{NTD}	1.5640***	1.9460***	3.569***	6.1130***
	(0.0000)	(0.0000)	*(1.92e-06)*	*(3.06e-07)*
β_{TV}	–0.5580***	–0.6560***	–1.104***	–2.073***
	(0.00471)	(0.0059)	*(0.00178)*	*(2.15e-05)*
B_{SC}	0.4520	0.6320	–1.934***	–3.021***
	(0.1400)	(0.1030)	*(9.02e-05)*	*(9.44e-06)*
β_{LIQ}	0.0045*	0.0077*	–0.0174	–0.0007
	(0.0803)	(0.0537)	*(0.122)*	*(0.9510)*
Constant	0.0638***	0.0580***	0.0786***	0.1080***
	(0.0000)	(2.39e-08)	*(0.0000)*	*(1.20e-05)*
Observations	1,344	1,344	1,344	1,344
Number of portfolio	14	14	14	14

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Contrarily to the case of JSE, Table 6 indicates that there are three main priced risk factors on NSE. Indeed, there is a positive and significant relationship between excess return and the 'number of traded stock', the 'number of trading' and the 'number of trading day.' Therefore, a unit increase of these variables risk lead to more than one unit increase on the related risk prices. This result holds for all estimation and portfolios building process and is even more important when beta portfolios are used for analysis. These results are consistent with those found by Easley et al. (2005), Chang et al. (2014), who used information asymmetry as a microstructure variable on the US market.

Concerning 'trading volume', the effect is inverse, meaning that it is stock with low trading volume which is supposed to receive risk premium and it true whatever the estimation and portfolio building process. This conclusion is against the one of Wang (2007) on the Taiwan Stock Exchange, and Singh et al. (2014) on the Chinese financial market, who find that there is a premium that remunerates the risk related to the trading volume as microstructure factor. Similarly, with 'SC' when beta portfolio is used. Moreover, there is no evidence of a significant liquidity risk premium on NSE. This result is in line with the conclusions of Miralles et al. (2011), who find that the liquidity risk is not priced on the Portuguese market.

Finally on NSE, 'number of traded stock', the 'number of trading' and the 'number of trading day' are microstructure variables which risk price are significant and the sign of the coefficients are in accordance with the theory. This can be explained by the fact that compared to JSE (who is the first African stock market in term of capitalisation), the NSE is ranked first according to the volume of traded shares. As it was with JSE, this result is robust to various model specifications as show by Tables 11 and 12. This robustness check indicates that independently of the type of portfolio formation process and estimation method, the results do not globally change because the pricing behaviour of all the microstructure risk factor remains the same, when removing some variables in the estimated model.

Table 7 The price of microstructure risk on the BRVM

BRVM	*Beta-liquidity portfolio*		*Beta portfolio*	
Variables	*GLS*	*GEE*	*GLS*	*GEE*
β_{NTS}	–0.1414	–1.0899	2.2145*	2.3174***
	(0.978)	*(0.652)*	*(0.0588)*	*(0.0000)*
β_{NT}	0.376	0.675	–0.178	–0.4440
	(0.450)	*(0.199)*	*(0.777)*	*(0.146)*
β_{NTD}	1.503	1.341	1.258	0.8660
	(0.130)	*(0.178)*	*(0.342)*	*(0.172)*
β_{TV}	0.695	1.169	0.346	–0.7700
	(0.526)	*(0.324)*	*(0.790)*	*(0.226)*
B_{SC}	1.429	2.671	–0.0272	–1.9390*
	(0.446)	*(0.188)*	*(0.990)*	*(0.0736)*
β_{LIQ}	0.00474	–0.0053*	–0.0006	–0.00022
	(0.981)	*(0.0542)*	*(0.874)*	*(0.1240)*
Constant	–0.0264***	–0.0105	–0.0337**	–0.0417***
	(0.00703)	*(0.411)*	*(0.0144)*	*(0.0000)*
Observations	576	576	576	576
Number of portfolio	8	8	8	8

Note: P-value in parentheses; $***p < 0.01$, $**p < 0.05$, and $*p < 0.1$.

4.3 Microstructure risk price on BRVM

On the BRVM, Table 7 indicates no significant evidence of microstructure risk. The only significant risks prices are obtained with liquidity when portfolio are formed on the basis of liquidity and systematic risk simultaneously in one hand and on another hand there is a significant and consistent risk price for 'number of trading stock' on beta portfolio. However, these evidences are so divergent that it is difficult to conclude that there is a significant risk premium on the concerned stock market. These results did not change in Tables 13 and 14 with different model specification. Indeed, in Table 14 where GEE is the estimation techniques on beta portfolio, in addition to the 'number of trading stock', the 'number of trading day' seems to be priced factors, but it holds only in the global model and when liquidity and 'number of trading stock' as variable are not considered in the model. BRVM thus behaves like the JSE since it is difficult to conclude that there is a premium relating to the microstructure effect. May be the fact of building the portfolios simultaneously with the stocks of all these markets (market globalisation) is a solution for the risk to be taken on asset pricing.

Overall concerning individual stock markets in Africa, a part from three variables on NSE, we cannot conclude that the price of microstructure risks is significant and consistent.

4.4 International portfolio management: a possible solution for the microstructure risk?

Managing a portfolio internationally consists of building a portfolio with the securities listed on several different financial markets. This process allows for a diversification of risk, and we supposed here that it would facilitate the consideration of risk in assets pricing in sub-Saharan Africa stock markets. When portfolios are formed internationally, the results of estimation are presented in Table 8.

Table 8 The price of microstructure risks with IPM

BRVM	*Beta-liquidity portfolio*		*Beta portfolio*	
Variables	*GLS*	*GEE*	*GLS*	*GEE*
β_{NTS}	3.301***	1.8952***	2.2521***	2.3856***
	(0.0070)	*(2.03e-07)*	*(3.99e-08)*	*(9.58e-05)*
β_{NT}	1.7710***	2.4360***	1.4366***	1.5630***
	(0.0098)	*(0.0000)*	*(0.0000)*	*(0.0000)*
β_{NTD}	1.0630***	1.140*	1.0707***	1.9200***
	(0.0009)	*(0.0614)*	*(0.0000)*	*(0.0090)*
β_{TV}	0.3290**	0.3120	3.1520***	1.9970***
	(0.0226)	*(0.1290)*	*(0.0000)*	*(0.0006)*
B_{SC}	0.7480***	0.2450**	5.129***	3.7140***
	(0.0023)	*(0.0484)*	*(0.0000)*	*(0.0001)*
β_{LIQ}	–0.0036	0.0005	0.0304	–0.0080**
	(0.1200)	*(0.8950)*	*(0.379)*	*(0.0190)*
Constant	0.0982***	0.115***	0.0333***	0.1410***
	(0.0000)	*(6.15e-08)*	*(3.66e-07)*	*(3.06e-05)*
Observations	1,920	1,920	1,920	1,920
Number of portfolio	20	20	20	20

Note: P-value in parentheses; ****p* < 0.01, ***p* < 0.05, and **p* < 0.1.

Table 8 shows that with the exception of liquidity factor, microstructure risk is globally priced when stocks of many financial markets are considered together in an international portfolio. Especially, five of the six studied variables have a significant risk and consistent risk prices. These are the NTD, the number of transactions, TV and the size of the company or SC. All these variables have a positive and significant risk price.

Table 9 Robustness check of the price of microstructure risk on JSE: GLS estimation method

GLS	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta–liquidity portfolio							
β_{NTS}	–3,2120***		–1,1900*	–3,1890***	–3,0950***	–3,2670***	–4,2440***
	(0.0066)		(0.0871)	(0.0066)	(0.0067)	(0.0062)	(0.0055)
β_{NT}	0.614	0.571		0.608	0.948**	0.844**	0.671
	(0.201)	(0.224)		(0.153)	(0.0193)	(0.0391)	(0.149)
β_{NTD}	0.0330	–0.0179	–0.633		–1.349***	–0.973**	1.361
	(0.977)	(0.987)	(0.525)		(0.00395)	(0.0256)	(0.144)
β_{TV}	–0.486	–0.484	–0.746**	–0.496***		–0.146***	–0.0286
	(0.198)	(0.200)	(0.0190)	(0.00159)		(0.00196)	(0.930)
B_{SC}	–0.505	–0.507	–0.880*	–0.520**	0.206***		0.204
	(0.365)	(0.363)	(0.0635)	(0.0160)	(0.00310)		(0.665)
β_{LIQ}	–0.00411**	–0.00419**	–0.00415**	–0.00414***	–0.00310**	–0.00333**	
	(0.0182)	(0.0156)	(0.0173)	(0.00531)	(0.0461)	(0.0277)	
Constant	0.157***	0.157***	0.158***	0.157***	0.144***	0.148***	0.117***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: beta portfolio							
β_{NTS}	–2.0410***		–1.7237	–1.5279	–2.0611***	–2.0362***	–2.0430***
	(0.0064)		(0.1740)	(0.3340)	(0.0009)	(0.0029)	(0.0060)
β_{NT}	1.2866***	1.2119***		1.1109***	1.0253***	0.9668**	1.2853***
	(8.28e-07)	(1.55e-05)		(0.0008)	(0.0074)	(0.0197)	(8.79e-07)
β_{NTD}	–3.0160***	–2.7700***	–2.9780***		–1.748***	–2.6870***	–3.0610***
	(0.0000)	(2.37e–10)	(7.33e-09)		(0.0001)	(2.01e–10)	(0.0000)
β_{TV}	2.7900***	2.3850***	2.4970***	1.1800***		1.2180***	2.8050***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(4.58e-07)	(0.0000)
B_{SC}	2.8320***	2.2590***	2.3410***	1.2050***	1.4530***		2.8550***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0000)
β_{LIQ}	–0.0013	–0.1700	–0.8300	–0.0391	–0.0535*	–0.0564*	
	(0.6680)	(0.5870)	(0.7920)	(0.2150)	(0.0950)	(0.0803)	
Constant	0.0626***	0.0659***	0.0633***	0.0962***	0.1130***	0.1190***	0.0615***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	1,536	1,536	1,536	1,536	1,536	1,536	1,536
Number of portfolio	16	16	16	16	16	16	16

Note: P–value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 10 Robustness check of the price of microstructure risk on JSE: the GEE estimation method

GEE	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta–liquidity portfolio							
β_{NTS}	−3,9760***		−3,9540***	−3,9520***	−2,8010**	−2,4360***	−3,8340***
	(0.0023)		(0.0029)	(0.0030)	(0.0440)	(0.0039)	(0.0082)
β_{NT}	−0.1040	−0.0929		0.7030	0.9540*	0.7780	−0.0299
	(0.8670)	(0.8820)		(0.1760)	(0.0598)	(0.1290)	(0.9590)
β_{NTD}	−3.095**	−3.090**	−2.975***		0.3360	−0.1270	−2.8860**
	(0.0162)	(0.0164)	(0.00568)		(0.5260)	(0.7980)	(0.0156)
β_{TV}	−1.2960***	−1.2490***	−1.2530***	−0.3380*		−0.1980***	−1.3660***
	(0.0037)	(0.0050)	(0.0005)	(0.0659)		(0.0003)	(0.0008)
B_{SC}	−1.6510**	−1.5920**	−1.5870***	−0.2040	0.2670***		−1.7900***
	(0.0134)	(0.0167)	(0.0037)	(0.4230)	(0.0012)		(0.0030)
β_{LIQ}	−0.0074**	−0.0072**	−0.0074**	−0.0078**	−0.0095***	−0.0094***	
	(0.0276)	(0.0306)	(0.0275)	(0.0134)	(0.0027)	(0.0028)	
Constant	0.0797**	0.0804**	0.0796**	0.0678**	0.0519	0.0549*	0.1320***
	(0.0217)	(0.0202)	(0.0215)	(0.0301)	(0.105)	(0.0866)	(0)
Panel B: beta portfolio							
β_{NTS}	−1.9934**		−2.0655***	−1.9611**	−2.0971***	−2.1044***	−1.9950**
	(0.0229)		(0.0049)	(0.0322)	(0.0030)	(0.0028)	(0.0218)
β_{NT}	0.7175	0.8947**		0.7938*	0.4149	0.2460	0.7191
	(0.172)	(0.0316)		(0.0917)	(0.482)	(0.634)	(0.170)
β_{NTD}	−1.236	−0.752	−1.712		−2.290***	−2.284***	−1.223
	(0.3250)	(0.5440)	(0.1590)		(0.0000)	(0.0000)	(0.3280)
β_{TV}	0.921***	1.126***	0.788**	1.244***		0.277***	0.923***
	(0.0093)	(0.0010)	(0.0215)	(0.0000)		(6.41e-11)	(0.0091)
B_{SC}	1.9230***	2.1980***	1.7100***	2.4440***	0.4650***		1.9270***
	(0.0006)	(7.19e-05)	(0.0017)	(0.0000)	(0.0000)		(0.0006)
β_{LIQ}	0.0036	0.0118	0.0065	−0.0026	0.0090	0.0140	
	(0.9250)	(0.7620)	(0.8670)	(0.9950)	(0.8180)	(0.7230)	
Constant	0.0958***	0.0966***	0.0970***	0.0885***	0.115***	0.121***	0.0960***
	(0.0006)	(0.0004)	(0.0006)	(0.0006)	(0.0001)	(7.50e-05)	(0.0005)
Observations	1,442	1,442	1,442	1,442	1,442	1,442	1,536
Number of portfolio	16	16	16	16	16	16	16

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 11 Robustness check of the price of microstructure risk for IPM: the GLS estimation method

GLS	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta–liquidity portfolio							
β_{NTS}	1.8554***		2.4706***	1.0329	1.7004***	1.7985***	1.8499***
	(0.0002)		(0.0000)	(0.5610)	(0.0057)	(0.0007)	(0.0003)
β_{NT}	1.1920***	1.2660***		1.2460***	1.1910***	1.1890***	1.1910***
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NTD}	1.5640***	1.2920***	2.2890***		1.3390***	1.4590***	1.5140***
	(0.0000)	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)
β_{TV}	–0.5580***	0.2790	–0.5390**	–0.0967		–0.2790***	–0.5590***
	(0.00471)	(0.128)	(0.0254)	(0.600)		(7.78e-07)	(0.00472)
B_{SC}	0.4520	0.1120	0.1620	–0.4550	–0.3780***		0.4400
	(0.1400)	(0.7020)	(0.6650)	(0.1190)	(1.67e-05)		(0.1510)
β_{LIQ}	0.0045*	0.0043	0.0041	0.0014	0.0046*	0.0044*	
	(0.0803)	(0.1000)	(0.1970)	(0.5800)	(0.0804)	(0.0862)	
Constant	0.0638***	0.0708***	0.0608***	0.0858***	0.0718***	0.0671***	0.0675***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel B: beta portfolio							
β_{NTS}	1.2350***		1.7850***	2.4900***	2.4600***	2.4670***	2.3300***
	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NT}	1.3209***	1.0310***		1.3942***	1.3773***	1.3879***	1.3283***
	(0.0000)	(2.73e-09)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NTD}	3.569***	6.203***	7.737***		1.434***	0.893***	3.348***
	(1.92e-06)	(0.0000)	(0.0000)		(3.32e-06)	(0.00389)	(5.44e-06)
β_{TV}	–1.104***	–2.578***	–3.361***	0.431***		0.278***	–0.985***
	(0.00178)	(0.0000)	(0.0000)	(0.00316)		(0.0000)	(0.00431)
B_{SC}	–1.934***	–3.666***	–4.961***	0.211	–0.393***		–1.763***
	(9.02e-05)	(0.0000)	(0.0000)	(0.3020)	(0.0000)		(0.000252)
β_{LIQ}	–0.0174	0.0066	–0.0358***	–0.0071	–0.0097	–0.0075	
	(0.122)	(0.957)	(0.00231)	(0.521)	(0.377)	(0.495)	
Constant	0.0786***	0.113***	0.139***	0.0559***	0.0615***	0.0576***	0.0753***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	1,344	1,344	1,344	1,344	1,344	1,344	1,344
Number of portfolio	14	14	14	14	14	14	14

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 12 Robustness check of the price of microstructure risk on NSE: the GEE estimation method

GEE	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta-liquidity portfolio							
β_{NTS}	1.9504***		2.4979***	1.2677	1.8220***	1.8923***	1.9411***
	(1.91e-05)		(0)	(0.336)	(0.000563)	(8.16e-05)	(2.86e-05)
β_{NT}	1.1880***	1.2730***		1.1990***	1.1740***	1.1770***	1.1870***
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NTD}	1.9460***	1.4550***	2.0800***		1.5640***	1.7220***	1.8980***
	(0.0000)	(0.0000)	(1.24e-10)		(0.0000)	(0.0000)	(0.0000)
β_{TV}	–0.6560***	0.2550	0.1400	–0.3880*		–0.8200***	–0.6350***
	(0.0059)	(0.2350)	(0.6430)	(0.0580)		(5.94e-06)	(0.0076)
B_{SC}	0.6320	0.1030	–1.0290**	–1.0020***	–0.3960***		0.6020
	(0.1030)	(0.7730)	(0.0383)	(0.0031)	(8.07e-05)		(0.1190)
β_{LIQ}	0.0077*	0.0064*	0.0009*	0.0005	0.0071*	0.0073*	
	(0.0537)	(0.0841)	(0.0958)	(0.2020)	(0.0703)	(0.0619)	
Constant	0.0580***	0.0687***	0.0621***	0.0843***	0.0678***	0.0629***	0.0646***
	(2.39e-08)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(7.90e-11)	(0.0000)
Panel B: Beta portfolio							
β_{NTS}	1.9140***		1.5630***	2.0490***	2.0760***	2.0300***	1.9140***
	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NT}	1.2574***	1.0472***		1.4036***	1.3932***	1.3935***	1.2579***
	(0.0000)	(6.45e-06)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NTD}	6.1130***	8.2180***	1.0606***		1.3070***	1.0790***	6.0980***
	(3.06e-07)	(9.81e-11)	(0.0000)		(0.0004)	(0.0035)	(1.68e-07)
β_{TV}	–2.073***	–3.237***	–4.503***	0.303**		0.0851**	–2.066***
	(2.15e-05)	(2.31e-10)	(0.0000)	(0.0490)		(0.0211)	(1.33e-05)
B_{SC}	–3.021***	–4.163***	–6.270***	0.300	–0.143***		–3.011***
	(9.44e-06)	(7.79e-09)	(0.0000)	(0.1570)	(0.0051)		(5.44e-06)
β_{LIQ}	–0.0007	0.0036	–0.0109	0.0127	0.0110	0.0120	
	(0.9510)	(0.7730)	(0.3760)	(0.2900)	(0.3570)	(0.3110)	
Constant	0.1080***	0.1520***	0.1690***	0.0723***	0.0747***	0.0750***	0.1080***
	(1.20e-05)	(0.000448)	(1.27e-07)	(0.00189)	(0.000656)	(0.00117)	(1.11e-05)
Observations	1,344	1,344	1,344	1,344	1,344	1,344	1,344
Number of portfolio	14	14	14	14	14	14	14

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 13 Robustness check of the price of microstructure risk on BRVM: the GLS estimation method

GLS	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta-liquidity portfolio							
β_{NTS}	–0.1414		–1.0595	–1.3428	–1.0253	–1.0464	–0.2660
	(0.978)		(0.603)	(0.321)	(0.616)	(0.619)	(0.983)
β_{NT}	0.376	0.383		-0.247	0.0808	0.0142	0.379
	(0.450)	(0.359)		(0.378)	(0.647)	(0.925)	(0.427)
β_{NTD}	1.503	1.517*	0.883		0.973*	0.881	1.509
	(0.130)	(0.0701)	(0.114)		(0.0698)	(0.120)	(0.116)
β_{TV}	0.695	0.713	–0.0794	–0.702		–0.134	0.705
	(0.526)	(0.419)	(0.838)	(0.238)		(0.351)	(0.487)
B_{SC}	1.429	1.456	0.0814	–0.900	0.252		1.445
	(0.446)	(0.363)	(0.886)	(0.401)	(0.306)		(0.411)
β_{LIQ}	0.00474	0.0003	0.00477	0.0082	0.0053	0.0058	
	(0.981)	(0.987)	(0.807)	(0.674)	(0.775)	(0.758)	
Constant	–0.0264***	–0.0263***	–0.0325***	–0.0362***	–0.0319***	–0.0331***	–0.0262***
	(0.00703)	(0.00292)	(2.01e-09)	(8.63e-07)	(0)	(0)	(0.000824)
Panel B: Beta portfolio							
β_{NTS}	2.2145*		2.2319**	2.1386*	2.1967*	2.2151*	2.2232**
	(0.0588)		(0.0412)	(0.0944)	(0.0584)	(0.0541)	(0.0471)
β_{NT}	–0.178	–0.498		–0.655*	–0.336	–0.171	–0.210
	(0.777)	(0.411)		(0.0812)	(0.101)	(0.462)	(0.724)
β_{NTD}	1.258	0.461	1.558**		0.954	1.271*	1.258
	(0.342)	(0.714)	(0.0492)		(0.158)	(0.0836)	(0.342)
β_{TV}	0.346	–0.357	0.693	–0.713		0.361**	0.290
	(0.790)	(0.774)	(0.102)	(0.282)		(0.0380)	(0.816)
B_{SC}	–0.0272	–0.825	0.563	–1.798	–0.619**		–0.142
	(0.990)	(0.709)	(0.498)	(0.149)	(0.0397)		(0.947)
β_{LIQ}	–0.0006	–0.00026	–0.0001	–0.00067	–0.0003	–0.00069	
	(0.874)	(0.530)	(0.792)	(0.875)	(0.929)	(0.864)	
Constant	–0.0337**	–0.0327**	–0.0307***	–0.0407***	–0.0367***	–0.0336***	–0.0352***
	(0.0144)	(0.0180)	(0.0006)	(0.0004)	(5.90e-06)	(2.26e-06)	(0.0004)
Observations	576	576	576	576	576	576	576
Number of portfolio	8	8	8	8	8	8	8

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 14 Robustness check of the price of microstructure risk on BRVM: the GEE estimation method

GEE	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta-liquidity portfolio							
β_{NTS}	–1.0899		–1.4186	–1.5027	–1.4230	–1.42/9	–1.0081
	(0.652)		(0.260)	(0.171)	(0.222)	(0.246)	(0.693)
β_{NT}	0.675	0.780*		0.117	0.190	0.0244	0.350
	(0.199)	(0.0844)		(0.713)	(0.387)	(0.896)	(0.472)
β_{NTD}	1.341	1.575*	0.445		0.622	0.463	1.265
	(0.178)	(0.0627)	(0.453)		(0.312)	(0.465)	(0.192)
β_{TV}	1.169	1.461	–0.183	–0.0661		–0.324**	0.503
	(0.324)	(0.121)	(0.706)	(0.929)		(0.0446)	(0.630)
B_{SC}	2.671	3.086*	0.214	0.623	0.640**		1.283
	(0.188)	(0.0736)	(0.766)	(0.639)	(0.0220)		(0.476)
β_{LIQ}	–0.0053*	–0.0054**	–0.0030	–0.0047*	–0.0036	–0.0027	
	(0.0542)	(0.0450)	(0.223)	(0.0853)	(0.144)	(0.254)	
Panel B: Beta portfolio							
β_{NTS}	2.3174***		2.3558***	2.2518***	2.3504***	2.3560***	2.3279***
	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(2.55e-09)
β_{NT}	–0.4440	–0.6820		–0.8060***	–0.0844	0.0811	–0.4930
	(0.146)	(0.214)		(3.60e-08)	(0.184)	(0.341)	(0.157)
β_{NTD}	0.8660	–0.1660	1.656***		1.532***	1.809***	0.8950
	(0.172)	(0.881)	(4.07e-07)		(9.12e-08)	(3.11e-07)	(0.226)
β_{TV}	–0.7700	–0.9920	0.1510	–1.537***		0.3640***	–0.8580
	(0.226)	(0.381)	(0.270)	(2.44e-08)		(2.75e-06)	(0.236)
B_{SC}	–1.9390*	–1.8860	–0.3850	–3.2100***	–0.6350***		–2.1910*
	(0.0736)	(0.349)	(0.175)	(1.47e-09)	(1.56e-07)		(0.0713)
β_{LIQ}	–0.00022	–0.00028	–0.00025	–0.00022	–0.00025	–0.00027	
	(0.1240)	(0.4250)	(0.1330)	(0.1730)	(0.1280)	(0.1230)	
Constant	–0.0417***	–0.0371***	–0.0348***	–0.0468***	–0.0358***	–0.0326***	–0.0464***
	(0.0000)	(0.0026)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	576	576	576	576	576	576	576
Number of portfolio	8	8	8	8	8	8	8

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 15 Robustness check of the price of microstructure risk for IPM: the GLS estimation method

GLS	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta-liquidity portfolio							
β_{NTS}	3.301***		3.493***	3.994***	3.740***	3.560***	3.581***
	(0.0070)		(0.0021)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NT}	1.7710***	1.7790***		0.3290	0.4450*	0.3560	1.7830***
	(0.0098)	(0.0089)		(0.2200)	(0.0898)	(0.1810)	(0.0087)
β_{NTD}	1.0630***	1.0350***	0.6920**		0.4530**	0.2760	1.1340***
	(0.0009)	(0.0009)	(0.0161)		(0.0107)	(0.1490)	(0.0003)
β_{TV}	0.3290**	0.3090**	0.1510	–0.0697		–0.0961**	0.3510**
	(0.0226)	(0.0229)	(0.2350)	(0.3830)		(0.0102)	(0.0148)
B_{SC}	0.7480***	0.7180***	0.4590**	0.0949	0.208***		0.7810***
	(0.0023)	(0.0021)	(0.0357)	(0.516)	(0.0010)		(0.0014)
β_{LIQ}	–0.0036	–0.0037	–0.0038	–0.0047**	–0.0041*	–0.0042*	
	(0.120)	(0.119)	(0.105)	(0.0413)	(0.0754)	(0.0684)	
Constant	0.0982***	0.0985***	0.101***	0.108***	0.104***	0.107***	0.0948***
	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Panel B: beta portfolio							
β_{NTS}	2.2521***		1.9687***	2.0974***	2.2136***	2.2036***	2.2567***
	(3.99e-08)		(0.00318)	(0.000267)	(1.12e-06)	(1.91e-06)	(2.69e-08)
β_{NT}	1.4366***	1.3410***		–0.5879	0.6608*	0.7454**	1.4328***
	(0.0000)	(0.0000)		(0.1420)	(0.0749)	(0.0340)	(0.0000)
β_{NTD}	1.0707***	1.0542***	0.8855***		0.5988***	0.6181***	1.0692***
	(0.0000)	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)
β_{TV}	3.1520***	3.0890***	1.6610***	0.7510***		0.0541	3.141***
	(0.0000)	(0.0000)	(0.0000)	(1.83e-09)		(0.1340)	(0.0000)
B_{SC}	5.129***	5.000***	2.764***	–1.192***	–0.00694		5.1290***
	(0.0000)	(0.0000)	(0.0000)	(4.34e-08)	(0.907)		(0.0000)
β_{LIQ}	0.0304	0.0428	0.0053	–0.0031	0.0138	0.0300	
	(0.379)	(0.217)	(0.878)	(0.932)	(0.697)	(0.399)	
Constant	0.0333***	0.0398***	0.0619***	0.111***	0.0920***	0.0920***	0.0337***
	(3.66e-07)	(8.13e-10)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(2.54e-07)
Observations	1,920	1,920	1,920	1,920	1,920	1,920	1,920
Number of portfolio	20	20	20	20	20	20	20

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 16 Robustness check of the price of microstructure risk for IPM: the GEE estimation method

GEE	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Panel A: beta-liquidity portfolio							
β_{NTS}	1.8952***		1.7157***	1.9182***	1.9195***	1.9056***	1.8950***
	(2.03e-07)		(0.0004)	(1.79e-08)	(1.17e-08)	(4.14e-08)	(2.06e-07)
β_{NT}	2.4360***	1.9630***		2.6440***	2.6190***	2.5180***	2.4360***
	(0.0000)	(1.40e-08)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
β_{NTD}	1.140*	1.599***	2.503***		0.317	0.777**	–1.135*
	(0.0614)	(0.0059)	(6.04e-06)		(0.285)	(0.0232)	(0.0623)
β_{TV}	0.3120	0.5210***	0.8110***	0.0242		0.1710***	0.3100
	(0.1290)	(0.0078)	(1.40e-05)	(0.8100)		(0.0004)	(0.1310)
B_{SC}	0.2450**	0.5670*	1.064***	0.2980	0.2710***		–0.240
	(0.0484)	(0.0925)	(0.000940)	(0.130)	(0.00112)		(0.492)
β_{LIQ}	0.0005	–0.0004	0.0005	0.0001	0.0001	0.0002	
	(0.8950)	(0.9920)	(0.8900)	(0.9740)	(0.9690)	(0.9580)	
Constant	0.115***	0.119***	0.123***	0.107***	0.109***	0.112***	0.116***
	(6.15e-08)	(1.31e-10)	(0.0000)	(2.02e-08)	(2.55e-08)	(2.99e-08)	(3.80e-08)
Panel B: beta portfolio							
β_{NTS}	2.3856***		2.2808***	2.3840***	2.4025***	2.4130***	0.4497
	(9.58e-05)		(0.00244)	(8.45e-05)	(4.52e-05)	(2.85e-05)	(0.946)
β_{NT}	1.5630***	1.5251***		1.5578***	1.6788***	1.6905***	1.2884***
	(0.0000)	(4.14e-10)		(0.0000)	(0.0000)	(0.0000)	(5.79e-06)
β_{NTD}	1.9200***	1.0730***	2.966***		2.629***	2.332***	1.4560
	(0.0090)	(0.00512)	(0.0000)		(0.0000)	(0.000)	(0.0027)
β_{TV}	1.9970***	2.2580***	4.6090***	2.0630***		0.2670***	–0.5330
	(0.0006)	(0.0001)	(0.0000)	(0.0000)		(6.71e-08)	(0.2440)
B_{SC}	3.7140***	4.2320***	7.9210***	3.8220***	0.4570***		–1.0180
	(0.0001)	(8.70e-06)	(0.0000)	(0.0000)	(1.53e-08)		(0.1810)
β_{LIQ}	–0.0080**	–0.0066**	–0.0127***	–0.0082**	–0.0033	–0.0028	
	(0.0190)	(0.0493)	(0.000252)	(0.0100)	(0.302)	(0.372)	
Constant	0.1410***	0.1600***	0.1860***	0.1420***	0.1000***	0.0946***	0.1130***
	(3.06e-05)	(1.03e-05)	(4.69e-07)	(8.18e-06)	(9.87e-05)	(0.000151)	(1.10e-07)
Observations	1,920	1,920	1,920	1,920	1,920	1,920	1,920
Number of portfolio	20	20	20	20	20	20	20

Note: P-value in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

For instance, for NTS, NT and NTD, a unit increase of risk in each of these variables will increase the related risk price for more than one unit. This proves that the associated risk factors are correctly priced on Sub-Saharan Africa stock markets, specifically when international portfolios management is used. Stocks or portfolios with low trading frequency receive a premium on these financial markets, no matter the portfolio formation process. This conclusion does not change with various model specifications as shows in Tables 15 and 16, where the only specificity is the fact that the risk price concerning the NTD is sometimes less than one in models 3, 5 and 6 of the above-mentioned tables. This result is in accordance with the conclusions of Wang (2007), who shows that information asymmetry produces a risk premium on the Taiwan Stock Exchange. It nevertheless contradicts the conclusions of Lambert et al. (2006) and Hughes and Liu (2005), according to whom the information risk should not be rewarded because market operators proceed to diversification.

Similarly, the TV and SC have a positive, significant and consistent risk price, but the value of the latter is higher than one only when beta portfolios are used. Consequently, there is a risk premium for holding low TV and small size stock when securities of several African stock markets are managed together in an international portfolio. This is confirming by the various model specifications (Tables 15 and 16) and it is consistent with the conclusion of Fama and French (1993), Nawazish (2008), Geert (1998) and Bollen and Dempsey (2010).

Concerning liquidity, the related risk price is not significant and consistent only when GEE estimation method is carried out on beta portfolio, thus there is no risk premium on African stock market individually and globally. This result does not change with different model specifications as presented in Tables 15 and 16 and is not consistent with the conclusion of Chan and Faff (2005), Chekilli and Abaoub (2013) and Bollen et al. (2008), that liquidity premium really and significantly exists.

5 Concluding remarks

The objective of this article was to evaluate if the microstructure risk was priced on sub-Saharan Africa emerging stock markets individually and globally (through international portfolio management). Daily data were collected for three sub-Saharan Africa emerging stock markets, that is: the JSE, the NSE and the 'Bourse Régionale des Valeurs Mobilières'. The estimation method used is that of Fama and Macbeth (1973), adapted to a portfolio panel analysis. The portfolios were built on the basis of the individual stock systematic risk criterion and following a double allocation technique, based on the liquidity and risk. This dual training was intended to provide several bases of statistical inference, as well as the use of several estimation techniques. In fact, the final model was estimated from the GLS and GEE methods. The results obtained show that on the basis of individual markets (JSE, NSE and BRVM), the microstructure's risk is far from being remunerated. The 'number of traded stock', the 'number of trading' and the 'number of trading day' are the only microstructure variables which have significant and consistent risk prices on NSE. This result is in accordance with the findings of Joher (2009), Dalgaar (2009), Chaff (2005), Chekilli and Abaoub (2013), Bollen et al. (2008) and Barend (2009). Furthermore, it is more likely that the premium exists only when listed stocks are managed in international portfolios. A part from liquidity, all microstructure variables are priced when portfolio are formed internationally. Finally, we can say that, compared to the individual stock markets, the IMP is more favourable to the reward of the microstructure risk on African stock markets. This can be explained by the advantages of integration (improvement of liquidity, reduction of the coast of capital and the opening of the market). This conclusion concerning the price of microstructure risk is in line with the one of Amihud and Mendelson (1986), Datar et al. (1998), Gervais et al. (2001), Acharya and Pedersen (2005), Wang (2007), Bollen et al. (2008), Singh et al. (2014) and Chang et al. (2014). This result highlights the important role of the globalisation of financial markets in Africa, hence there is a need for them to come together in order to benefit from pooling effects. Investors in individual markets should adopt a buy-and-hold strategy, as they will not receive any premium for the different microstructure risks. Additionally, when they hold portfolios made of stocks of several African financial markets, they should, to a certain extent, be interested in a buy-and-sell strategy. Moreover, financial-market participants would benefit from facilitating the flow of information in order to reduce transaction costs. The direct implication of these results is that the African financial market would benefit from forming a single block. To achieve this, it would be necessary, among other things, to facilitate the flow of information, reduce transaction costs (e.g., the initial public offering cost), accelerate and facilitate diplomacy for the existence of a single financial market in Africa, increase the number of trading days for non-continuously listed markets, increase the number of listed companies, etc. the limitations of this study are mainly related to the sample size (the study concerns only three African markets), the time dimension (which is limited between 2000 and 2014, due to unavailability of data), the estimation strategies used (other estimation techniques could have been used) and the microstructure variables (some variables such as information asymmetry and many others were not considered). Other research could focus on another microstructure risk variable (such as information asymmetry), other African markets or other portfolio formation strategies and for another time period. Another research could investigate the analysis following the orientation of downside risk. Furthermore, future research could investigate the causal relationship between returns and microstructure factors in order to identify new foundations for measuring the efficiency of African stock markets.

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Notes

1 It is the process by which the buyers and the sellers meet themselves on the market and agree on the security price

2 We use a month base analysis because it is the time unit of the study.

3 The methodology of Fama and Macbeth (1973) has become the standard approach in estimating and testing different versions of CAPM and Ross's APT (1976).

4 The betas obtained at the first step represent the variables used to estimate the parameters (gammas) of the second step.