“Are Asian exchanges outliers? A market quality criterion”

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ARE ASIAN EXCHANGES OUTLIERS? A MARKET QUALITY CRITERION

Abstract

This paper provides a practical, empirical and theoretical framework that allows investment managers to evaluate stock exchanges' market quality when choosing among different plausible international trading venues. To compare trading exchanges, it extends the hypothesis of market microstructure invariance to trading across exchanges. A measure ω, the ratio of the market-wide volatility to microstructure invariance, is introduced. The paper computes ω for the exchanges around the world. Its value for the NSE (India) is 24.5%, the Korea Exchange (Korea) is 7.9%, the Shanghai Exchange (China) is 3.5%, and the Shenzhen Exchange (China) is 4.4%, which is significantly different from that of major exchanges in the USA (NYSE – 0.8%, NASDAQ – 1.3%) and Europe (LSE (UK) – 0.4). This country risk dimension clearly identifies which equity exchanges cannot hold their own direct correlational hedges and therefore mandatorily require derivative positions, and has significant implications for the decision making of global long-short equity asset allocators in the Asian listed equity markets.

Keywords global asset allocation, international diversification, country risk, trading venues, market quality of stock exchanges, market microstructure

JEL Classification G11, G14, G15

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INTRODUCTION

This study is motivated by the need to provide a structured framework for global publicly traded equity asset allocators to choose trading venues in terms of the ease of position taking and hedging, and the quality of these markets. These asset allocators are assumed to be portfolio managers who represent investors seeking the benefits of diversification by investing in international equity markets. Such global investment portfolios could be managed by either a strategy of bottoms-up stock picking or influenced by a suitable index (such as the MSCI Emerging Markets (EM) Index). Whether there are diversification benefits from international asset allocation and in what form is an essential research topic in the decades following increasing financial integration? Although the evidence is inconclusive, portfolio managers would likely stand to benefit from broadening the existing set of criteria used by them, since new criteria might potentially create additional return/risk drivers apart from the primary diversification benefits that investors seek. Even passive investing styles benefit from this approach, since index inclusion rules incorporate features such as access, regulation, governance standards, and free-float considerations, which serve as broadening criteria.

Can the market quality offered by an equity exchange be such a criterion? The market quality represents liquidity, which portfolio managers usually monitor through the impact cost. The ease of execution can directly influence the trading venue selection decision of any large portfolio manager. Finally, portfolio managers optimize both on the

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risk and returns. They increasingly seek the ability to effectively enter a market and unwind hedge positions in real time. If market quality is a criterion, how can this idea be operationalized? This paper explores solutions rooted in the latest innovation in market microstructure theory and practice.

1. LITERATURE REVIEW

Global asset allocation is based on the benefits derived from diversification. This paper proposes to incrementally add the criteria available to global asset allocators to the existing arsenal of techniques. It is important to understand the benefits and limitations of existing criteria. Early contributions by Grubel (1968), Lessard (1973), and Solnik (1974) established the idea that investors can benefit from international diversification. The risk reduction intended is due to low correlations between the equity returns between different countries (Durai & Bhaduri, 2011; Balli et al., 2014).

Dahlquist and Harvey (2001) provide a framework of three models of asset allocation such as benchmark, strategic, and tactical asset allocation. According to Harvey[1], executing global investment mandates requires incorporating into the model economic indicators related to inflation, business cycles, fundamental asset valuation, default risk, market microstructure, political risk, momentum, and sentiment. Erb et al. (1995) offer country credit ratings as a proxy for country risk. Arnott and Henriksson (1989) show that changes in relative risk premiums between two equity markets can provide a measure of changes in relative valuation.

Portfolio managers consider country or industry-level factors and the equity market characteristics of destination countries while making allocations (Thapa & Poshakwale, 2012). Factors such as the size, trading cost, taxation, and impact cost (liquidity) are important. Liquid and more efficient markets, with lower trading costs, are given higher allocation. Other aspects that have been found to influence capital flows are the quality of institutions and cultural factors (Aggarwal et. al., 2012; Thapa & Poshakwale, 2012).

International financial integration has been seen to have had the effect of reducing the importance of country-specific factors, as compared with global factors, in their contribution to portfolio returns (Kim & Lee, 2017). In addition, global linkages bring additional risks to portfolio returns. Akbari et al. (2020) show that the Emerging Markets (EMs) are rapidly getting integrated into world markets. Loong and Har (2017) find that Asian EMs are moving towards higher integration, and hence diversification benefits may not be available in the long run. Solnik and Watewaib (2019) find that international market correlation increases sharply during global crises and suggest adapting allocation for changing correlation and volatility.

In contrast, Bekaert and Harvey (2017) have argued that DMs and EMs are not fully integrated. Lack of integration accounts for the lower allocation to EM equity than the EM share (40%) in the world GDP. It also results in the 'segmentation' of markets. Regulatory hurdles for foreign investors in several countries cause segmentation. Globalization reduces segmentation by inducing greater economic and financial openness. However, the evidence is not conclusive as yet, since investors can clearly seek hitherto undiscovered benefits from a globally diversified portfolio even in the presence of moderated global diversification benefits.

EM equities provide a unique diversification opportunity for developed market (DM) funds. The active investment decisions include a) weight of EMs relative to DMs; b) market capitalization weighting across EMs; and c) selecting securities in each EM. The high 'expected returns' from EMs compensate for the higher risk in these markets (Harvey, 2012).

Koepke (2015), using a meta-analysis of over 40 empirical studies, concludes that push factors (global risk aversion, mature economy interest rates, and output growth) matter most for portfolio flows. Pull factors (domestic output growth, asset returns, country risk) also affect portfolio

1 Global TAA course, Campbell R. Harvey, Duke University.

flows. The measures of country risk have practical applications in implementing global portfolio strategies, risk control, and understanding the sources of returns (Erb et al., 1997).

Hsieh and Nieh (2010) show that the constraints in Asia remain in the legal framework, market infrastructure, and corporate governance mechanisms. Driessen and Laeven (2007) provide evidence that diversification benefits vary over time due to changes in country risk.

Ahmad et al. (2015) compare the determinants of foreign portfolio investments in China and India. They found out that external debt was the most significant factor in the case of China. Garg and Dua (2014) and Srinivasan and Kalaivani (2013) showed that GDP growth, FDI, domestic inflation, equity market returns, exchange rate, and returns associated with US equity markets are determinants of foreign inflows into India. Higher equity returns of other emerging economies can reverse the flows (Jacob & Raphael, 2019).

Ramkumar et al. (2019) argue that the response to greater cross-country correlations is to invest in a broad set of companies. The improving market characteristics in Asia, local regulations, local retail investor activity implies that institutional hedge fund portfolios should allocate more to Asia focused hedge fund strategies. Hsu et al. (2020) argued for an increase in allocation to Chinese onshore equities as they offer investors faster earnings growth along with low correlation with onshore and global markets.

Mensah and Premaratne (2014), Apong (2012), and Mensah and Premaratne (2019) find that in Asia-Pacific countries and Asian markets, regionally diversified portfolios provide higher gains than global diversification. Kolluri et al. (2020) show the use of an alternate correlation measure – 'factor model-implied correlation' to measure financial integration and determine the optimal US and Asian equity asset-allocation weights, provided improved diversification gains.

Some possible measures to select equity markets based on the microstructure characteristics, as suggested by Harvey [2] include: Trading volume, volume divided by number of shares issued, turnover, number of margin trades, short interest rate and short interest change, volatility (among the constituent stocks in the index), asset concentration ratios, and industry concentration ratios.

Jain (2003) investigated 51 stock exchanges based on the trading mechanism and other structural features. The study highlighted the importance of institutional characteristics for liquidity measures such as closing bid-ask spreads, volatility, and trading turnover in classifying trading venues.

Market microstructure invariance hypothesis presents an alternative technique to evaluate listed trading venues. The characteristics of the microstructure of exchanges, such as bid-ask spread, the size of orders, the speed at which orders are received, the price impact from trades, and bid-ask spread, vary across assets and across time. Kyle and Obizhaeva (2016) show that "…these variations almost disappear when these characteristics are examined at an asset-specific "business-time" scale which measures the rate at which risk transfers take place". Andersen et al. (2016) and Benzaquen et al. (2016) have empirically confirmed that the invariance principle held true for intraday observable quantities. Pohl et al. (2017) give a theoretical understanding of the reasons why dimensional analysis can yield powerful results.

2. AIMS

The purpose of the paper is to introduce a set of metrics to evaluate global exchanges, specifically by introducing the application of the invariance of trades in an exchange hypothesis. Global fund managers can then include these metrics into their criterion sets.

The following research questions are formulated in the paper:

1. Is the invariance of trades on an exchange a measure of country risk that global asset managers can use to allocate funds?

2 Global TAA course, Campbell R. Harvey, Duke University.

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2. Can diversification benefits come from the quality of markets?

3. What is the impact of competition on market quality?

In section 3, the market microstructure invariance hypothesis is extended to the hypothesis of invariance of trades in an exchange, invoking the idea of considering the stock market as a complex system.

3. METHODOLOGY AND HYPOTHESIS DEVELOPMENT

An empirical hypothesis is developed to examine the data representing the business of exchanges. It is posited that the invariance of trades is essentially the invariance of risk flow. Market microstructure invariance of trades would be a natural consequence if financial markets were recognized as a complex system. The stock market and capital markets have been identified as adaptive complex systems (Mauboussin, 2002). Properties of complex systems include aggregation, adaptive decision rules, nonlinearity, and feedback loops. The presence of scaling laws characterizes them. By the principle of scaling, the stock exchange that structurally represents one level higher than the trading of an individual asset, should also display invariance of risk flow. Market microstructure invariance hypothesis is extended to exchanges. Instead of establishing specific scaling laws to prove such an extension, this study relies on the general concept of scaling. Complex system characteristics are invoked to extend the invariance of bets to the invariance of trades on an exchange.

A stock exchange could be analyzed on the basis of its risk handling function by considering it as having a finite sum of traded assets, weighted by the business time of each asset. It can also be represented by a notional stock. The risk transfer observed under the invariance hypothesis is an outcome of complex system properties when investors who allocate capital and transfer risk interact. The interactions in a complex system result in layers of similar patterns. In this context, moving from an individual stock to the exchange level is analogous to moving one level higher in an organizational hierarchy.

The empirical hypothesis of the invariance of trades on an exchange is developed below to investigate certain microstructure properties of exchanges.

Define P_{jt} as the price of the asset; V_{jt} as the trading volume (all trades), measured in the number of shares per day. Let one unit of business time of the market be denoted by $1/\gamma_{jt}$, where γ_{jt} is the expected arrival of trades; Return volatility in one unit of business time equals $\sigma_{jt} \cdot \gamma_{jt}^{-1/2}$. Let I_{jt} denote the value in dollars of the amount of risk transferred in a business time unit. Since the key role of financial markets is to transfer risks, trades can be measured in terms of the risk transferred. This method can be used as a basis to compare markets. Define:

$$I_{jt} = P_{jt} \cdot Q_{jt} \cdot \sigma_{jt} \cdot \gamma_{jt}^{-\frac{1}{2}}. \qquad (1)$$

The variable I_{jt} in equation (1) is a measure of the economic content of trades in a market. Further, it is assumed that among the large and more relevant exchanges cost differentials are minimal. Additional variables such as cost or spread is not considered (unlike Benzaquen et al. (2016) and Pohl et al. (2017)), as cost of trading is not a market observable and spreads have dramatically decreased.

The empirical hypothesis in this paper titled Invariance of Trades on Stock Exchanges is as follows:

H: When examined in business time, the distribution of the risk (dollars) transferred by a representative trade is the same across markets. There is a random variable I_{Mjt} such that for any market j and time t, $I_{Mjt} \overset{d}{\Rightarrow} I_M$, i.e., the distribution of risk transfers in a market, I_{Mjt} is a market microstructure invariant.

Subscript 'M' emphasizes a market level variable in contrast to the original hypothesis; 'd' refers to convergence in distribution.

Define W_{jt} as the product of expected dollar trading volume $P_{jt} \cdot V_{jt}$ and calendar returns volatility σ_{jt}:

$$W_{jt} = \sigma_{jt} \cdot P_{jt} \cdot V_{jt}. \quad (2)$$

The risk transferred by all the trades during a calendar day is measured by this trading activity. The trading volume expressed in terms of the arrival of the trades and the expectation on the size and combining with (1).

$$W_{jt} = \sigma_{jt} \cdot P_{jt} \cdot \gamma_{jt} \cdot E\{|Q_{jt}|\} = \gamma_{jt}^{3/2} \cdot E\{|I_M|\}. \quad (3)$$

Under the invariance hypothesis, since the risk transfer in business time is constant, the market velocity can be inferred from the trading activity, and vice-versa. Under additional assumptions of an equilibrium trading and market clearing, trades per day can give the market velocity. The dollar trading volume $P_{jt} \cdot V_{jt}$ is given by the turnover per day.

Rearranging (2) and (3) leads to (4):

$$\frac{\sigma_{jt} \cdot P_{jt} \cdot V_{jt}}{\gamma_{jt}} = \gamma_{jt}^{\frac{1}{2}} \cdot E\{|I_M|\}, \quad (4)$$

$$I_M = \sigma_{jt} \frac{S_{jt}}{\gamma_{jt}^{1/2}}. \quad (5)$$

In (4) and (5) P_{jt} – price of the asset; V_{jt} – trading volume (no. of shares per day); γ_{jt} – expected arrival of trades $\gamma_{jt}^{\frac{1}{2}}$ is business time; σ_{jt} – calendar returns volatility; S_{jt} – Turnover-per-trade; and I_M – distribution of risk transfers in the market.

In (5), the business time and Turnover-per-trade (a constraint in the dataset) are known. For the trade sizes in a given percentile in an exchange, the same amount of risk is transferred in business time and hence I_M is invariant. While exchanges are being compared, (5) can be rewritten to an expression for the risk in terms of standard deviation of daily returns.

$$\sigma_{jt} = \frac{\gamma_{jt}^{1/2}}{S_{jt}} I_M = \omega_{jt} I_M. \quad (6)$$

Therefore, the standard deviation of daily returns is ω multiplied by an Invariant constant of proportionality. ω is a proxy for risk, the actual risk is ω dampened by I_M. I_M becomes invariant when comparing the same percentile of trade size (risk transfers in business time) between two exchanges.

The data for this study comprises the statistics released by the World Federation of Exchanges based on the structured reporting by the constituent members. The dataset is monthly data for the period 2004–2018, depending on whichever stock exchange was a member and reporting. The data available for the equity stocks and some specific statistics from the derivative segments is used. A comparative analysis of the exchanges for the year 2018 is presented below.

In 2018, out of the total 88 stock exchanges in the sample, there were 74 exchanges for which the turnover-per-day (Units: USD millions) could be computed. The choice of this statistic is arbitrary. The turnover-per-trade is computed using the turnover per day as well as the trades per day. The range of turnover-per-trade is 412 to 184,562 (USD million per day) among 74 exchanges. The exchanges are sorted based on the total turnover per day in 2018. The median turnover is USD 379.3 million. The bottom half of this group has several outliers of turnover-per-trade. The range of the top half is 378.5-16,982.8 and the range of the bottom half is 37.5-184,562.5. In the next stage of the analysis, the focus is on the top-half of this group. 36 stock exchanges are picked leaving out the 37th exchange so that 4 equal quartiles of 9 stocks each

Table 1. Quartile statistics for the turnover-per-trade (2018)*

Quartile statistics	Q1	Q2	Q3	Q4
QUARTILE-AVERAGES	7029.1	6961.6	5736.4	5451.7
ADJUSTED (REMOVED TWO LOWEST)	8528.5	8513.9	6896.8	6772.8
ADJUSTED (REMOVED TWO HIGHEST)	5657.9	4546.8	3810.3	3025.2
ADJUSTED (REMOVED LOWEST AND HIGHEST)	7154.7	6465.7	4926.7	4746.1
MAX	12112.4	16982.9	15677.9	15464.7
MIN	1066.1	412.1	1462.9	378.5
MEDIAN	7987.9	5286.8	4844.0	3199.0

Note: * Number of stocks in a final sample is 36.

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remain in the sample. The dataset consists of 36 stock exchanges as given in Table A1 (Appendix). In terms of averages, the first quartile is similar to the second quartile and the third quartile is similar to the fourth. The outliers can help to ascertain some trends. Table 1 gives a summary of the quartile statistics for Turnover-per-trade for the year 2018.

4. RESULTS

Table 2 gives the values of ω for the entire sample of 74 exchanges in 2018. The risk that the exchange is exposed in terms of the standard deviation of daily returns is clearly proportional to ω. The constant of proportionality is the Invariant measure. The invariance is at the level of distribution of trades. Trades that occupy similar positions in the distribution may be compared.

The outliers in ω point to the possibility of very high standard deviation of daily returns. In 2018, the average for the measure was 1.1%. Fourteen exchanges had a value of ω greater than 1. Within this group, the measure for NSE is the largest at 26%. Similarly, the BSE (9.5%), the Korea Exchange (9.3%), the Shenzhen Exchange (4.5%), and the Shanghai Exchange (3.5%) are large markets with large values for ω. To compare the

Table 2. 2018 values for ω; $\gamma_{jt}^{1/2}$ (sqrt (trades per day)) upon S_{jt} (turnover per trade)

Sl no.	Stock exchange(se)	ω	ω -50th
1	NSE (India)	26.0%	24.4%
2	BSE India	9.5%	9.5%
3	Korea Exchange	9.3%	7.9%
4	Bermuda SE	6.1%	
5	Shenzhen SE	4.5%	4.4%
6	Shanghai SE	3.5%	3.5%
7	Dhaka SE	2.1%	
8	BM & FBOVESPA S.A.	1.6%	0.6%
9	Borsa Istanbul	1.6%	0.7%
10	Moscow Exchange	1.5%	
11	Bolsa Mexicana de Valores	1.5%	0.2%
12	Indonesia SE	1.3%	
13	Australian SE	1.1%	0.4%
14	NASDAQ – US	1.1%	1.3%
15	Tehran SE	0.9%	0.3%
16	Japan Exchange	0.8%	
17	NYSE	0.7%	0.8%
18	Chittagong SE	0.7%	
19	Taiwan SE	0.7%	
20	BATS Chi-x Europe	0.7%	
21	TMX Group	0.6%	
22	Philippine SE	0.6%	
23	Hochiminh SE	0.5%	
24	Bursa Malaysia	0.4%	
25	Hong Kong	0.4%	
26	NASDAQ Nordic	0.4%	
27	Taipei Exchange	0.4%	
28	LSE	0.4%	
29	SE of Thailand	0.4%	
30	Euronext	0.3%	
31	Johannesburg SE	0.3%	
32	Warsaw SE	0.3%	
33	Oslo Bors	0.2%	
34	Iran Fara Bourse SE	0.2%	
35	Ukrainian Exchange	0.2%	
36	Egyptian Exchange	0.2%	

Note: Based on the relation $\sigma_{jt} = \left(\gamma_{jt}^{1/2} / S_{jt}\right) I_M,\ I_M = \omega I_M$; std dev of daily returns is proportional to ω; ω -50th is ω for 50th percentile trade for selected exchanges.

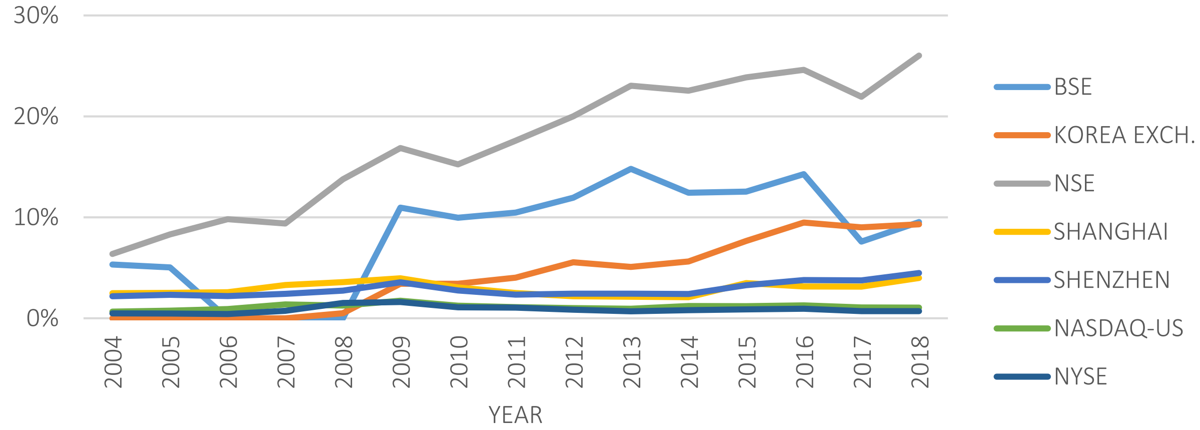

Figure 1. Trends in ω in 2004–2018

Table 3. Trends in ω from 2004 to 2018 in emerging Asian stock exchanges (in percent)

Stock exchange	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BSE	5.3	5.0				11.0	10.0	10.5	11.9	14.8	12.4	12.6	14.3	7.6	9.5
KOREA EXCHANGE					0.5	3.4	3.4	4.0	5.6	5.1	5.6	7.7	9.5	9.0	9.3
NSE	6.4	8.3	9.8	9.4	13.8	16.9	15.2	17.6	20.0	23.0	22.5	23.9	24.6	21.9	26.0
SHANGHAI SE	2.5	2.5	2.6	3.3	3.6	4.0	3.1	2.5	2.2	2.1	2.1	3.5	3.2	3.1	3.5
SHENZHEN SE	2.2	2.3	2.2	2.4	2.7	3.6	2.8	2.3	2.4	2.4	2.4	3.3	3.8	3.8	4.5
NASDAQ – US	0.67	0.77	0.91	1.38	1.27	1.74	1.25	1.11	1.00	0.94	1.22	1.20	1.29	1.08	1.06
NYSE	0.48	0.47	0.42	0.74	1.52	1.61	1.09	1.05	0.86	0.69	0.81	0.88	0.95	0.71	0.72

above exchanges the following example controls for similar trades.

Consider the ω for the trade at 50^{th} percentile as an example. The 50^{th} percentile for per day turnover-per-trade is computed using the data for 2004–18 and then using the trades-per-day data for 2018, the value of ω for select exchanges given in table 3 is found. In this case, for each exchange, $\sigma \propto \omega$ as I_M is constant. NSE (24.4%), BSE (9.5%), Korea exchange (7.9%), Shenzhen (4.4%), and Shanghai (3.5%) are large outliers in implied risk. Contrast this with NASDAQ – US (1.3%) and NYSE (0.8%).

Figure 1 and Table 3 give the trends in ω in the key Asian emerging stock exchanges for the period 2004–2018. The Asian exchanges are compared with NYSE and NASDAQ – US, the two leading US exchanges. The key outliers are the NSE and the Korea Exchange. The implied risk for the Korea Exchange has been increasing secularly from a low value of 3.43% (2009) to 9.3% (2018). For the NSE, the measure has an increasing trend with large values in the last five years. For example, the average of ω in the first six years is 10.76%; while for the next six years, it is 23.67%. Similarly, Shanghai and Shenzhen exchanges show an elevated average implied risk in the last five years over the previous five years.

To compare, NASDAQ-US is the 14th exchange with a measure of 1.1%, and NYSE is at 0.7%. The outliers are the big Asian exchanges.

Table 4 gives a snapshot of the activity level on a few exchanges in the stock and index futures and options. The NSE and the Korea Exchange have unusually high derivative market activity as compared to any other exchange. In China, derivatives are traded in separate exchanges.

The turnover-per-trade on the exchanges over the period 2004–2018 is examined to study the effect of competition on the stock exchanges. In Table A2 (Appendix), the 2004 values are normalized to 1 and all the values are restated based on the 2004 base.

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Table 4. Derivative business (2018)

Stock exchange	Stock opt-fut		Index opt-fut		Stock underlying	
	Number of contracts	Turnover	Number of contracts	Turnover	Turnover per day	Trades per day
NASDAQ – US	702389037	NA	3514163	NA	173928.5	15066.9
NYSE	444946374	145493	NA	NA	91397.6	7545.8
BSE	295	2.76	393	5.09866	492.6	1301.2
HONG KONG	126535890	431777.1	165867271	18434650	33671.2	1851.46
NSE	423031242	4233880	2283851902	28586353	4739.1	11500.1
KOREA EXCHANGE	520467161	341874	775921073	49862850	10488.3	9837.8
SHANGHAI SE					25268.8	9231.7
SHENZHEN SE					31277.2	12531.3

Note: The NSE and The Korea Exchange show contrasting derivative and cash segment activity.

5. DISCUSSION

The results in section 4 show that the implied risk is significantly higher in a group of Asian exchanges than the actual values observed. The measure 'ω' has an increasing trend (Figure 1) with large values in the last five years. The physical meaning is that the number of transactions is far larger than the relative value of the trades. A possible explanation for the outlier values in the measure 'ω' could be the large numbers of illiquid stocks in such markets (some of them small cap) that are low priced stocks and traded in large numbers of transactions but low overall volumes. Another potential explanation is that the trade sizes of large and liquid stocks are relatively small. The exchanges in question have been adding new SMEs and large companies after initial offerings.

An argument to explain the puzzle is that risk transfer in the index and stock derivatives leads to fewer transactions and a lower turnover of the larger stocks. This argument is a likely explanation for the NSE and the Korea Exchange. BSE is a relatively small exchange and does not have a large derivative market. It lists and trades more small and medium enterprises. The Korea Exchange, like the NSE, has a significant and active derivative segment. However, the skew towards the derivative segment is not high as on the NSE and it could explain the difference in implied risk. The evidence from Chinese exchanges challenges this explanation.

In China, derivatives are traded on different exchanges. Also, the exchange risk measure is actually increasing in the last few years where one expects it to reduce because Chinese markets are further liberalizing. The Asian exchanges are monopolies. The intuition in this paper is that the antidotes for reducing the implied risk levels on exchanges are competition, expansion of the pie by enlisting international equity, primary listing, and a check on the derivatives segment trading. Derivative trading is discussed below, and the characteristics of the EMs are discussed further in the next.

Is there a relationship between implied risk and derivatives trading? As Table 4 shows, the NSE and the Korea Exchange have unusually high derivative market activity. The NSE has a relatively smaller turnover per day in the equities markets. If some amount of the required risk transfers moves back into the equities market from the derivative segment, it can correct the turnover imbalance. This study has not tested whether the anomaly is favorable to investors or is harmful in any way.

The inference that excessive derivatives trading affects the market quality of underlying stocks has limited support by existing literature. Most empirical studies have reported a positive and beneficial relationship of the index or the stocks derivatives on the underlying stocks (Mayhew, 2000; Kim et al., 2006). Liu (2009) finds that the introduction of S&P 100 options in March 1983 resulted in lower volume, spread and volatility, but did not change the price of the underlying stocks. He suggests that this supports the idea that index derivatives' arrival encourages informed and speculative portfolio traders to move from the underlying market to the derivatives market. Liu (2010) notes that regulatory constraints may have a role in increasing the price and volatility in underlying stocks.

China, India, and Korea present a unique opportunity to investors, and the outlier characteristics of the exchanges may be due to their uniqueness. By the end of October 2019, EM companies in Asia accounted for 72% of the MSCI EM Index share.

China and India represent 40% of the world's population and churn out 25% of scientists and engineers graduating worldwide. China attracts higher FDI than India and maintains a high investment rate (Paul & Mas, 2016). While India is a global leader in services and promotes manufacturing locally for its domestic market, China has dominated global manufacturing and exports. Paul and Mas (2016) cite advantages for China over India, including political pressures on Indian governments owing to cultural diversity. Korea is a manufacturing and export leader in several industries such as textile, consumer goods, automobiles and heavy engineering.

The Chinese corporate landscape and hence the stock markets are dominated by large state-owned enterprises. The exchanges (Shanghai and Shenzhen) are among the largest stock exchanges. A total of 3,584 companies were listed by the end of 2018 representing a USD 6,324 billion market capitalization. The recent trend (OECD, 2019) sets up joint ventures or offshore listings to connect financial markets in Europe and China. These developments may be viewed as fostering competition in the markets. Since 2014, international investors have access to Shenzhen and Shanghai exchanges through the Hong Kong Exchange and domestic Chinese investors to the Hong Kong H-shares. Hence, an increase in the implied risk measure in Chinese exchanges presents a puzzle. Does the two-way connect lead to an outflow of trading liquidity from the domestic market to the Hong Kong market?

The large promoter group holding (State-owned or Private) in China and India tends to reduce institutional ownership of floating shares leading to lower trading and lower sized trades.

The Indian equity markets offer international investors a mature ecosystem with relatively longer equity market traditions. NSE and BSE are at par with major exchanges in technology implementation. While foreign portfolio flows can move unrestricted, investors are wary of the currency volatility that emerges from the country's weak current account and balance of payments position. Indian economy does not have a strong export orientation. The currency volatility is especially high during high oil price regimes (Prakash, 2012). The index derivative products such as the Nifty and Bank-Nifty are among the largest traded contracts in the world.

The Korea Exchange is adequately represented in the MSCI emerging market index with a weight that corresponds to the share of the Korean economy in the world GDP. Non-financial Korean companies regularly tap the equity markets to raise capital through secondary public offerings (USD 10 billion annual average) along with new IPOs. The Korea Exchange, the NSE, as well as Shanghai and Shenzhen exchanges have done well in new listings as shown in Figure 2. The Korea Exchange had 2,207 companies listed on it by the end of 2018, providing regular opportunities for foreign portfolio investors to deploy capital.

What is the impact of competition on the stock exchanges? The turnover-per-trade (Appendix, Table A2) changes with economic conditions. In the case of the USA, this number increases if their specific constituents do better. Due to competition and fragmentation of markets, the relative change across years is less in the USA. On the exchanges dominated by commodity stocks (BM&FBOVESPA or Moscow), the asset price cyclicality influences the turnover-per-trade measure.

European bourses, that faced fragmented markets and competition after the introduction of MiFID 1 regulations, show evidence of the per day turnover-per-trade measure falling to much lower levels. The fall ranges between 35% and 90%.

Asian exchanges have had low absolute measures of the per day turnover-per-trade, possibly highlighting the shallow markets. In the Chinese exchanges, the measure has surprisingly doubled. The measure has fallen in Korea by 83%, NSE by 33%, and BSE by 29%.

The per-day turnover-per-trade is an important measure, since it is the unit in which risk is trans-

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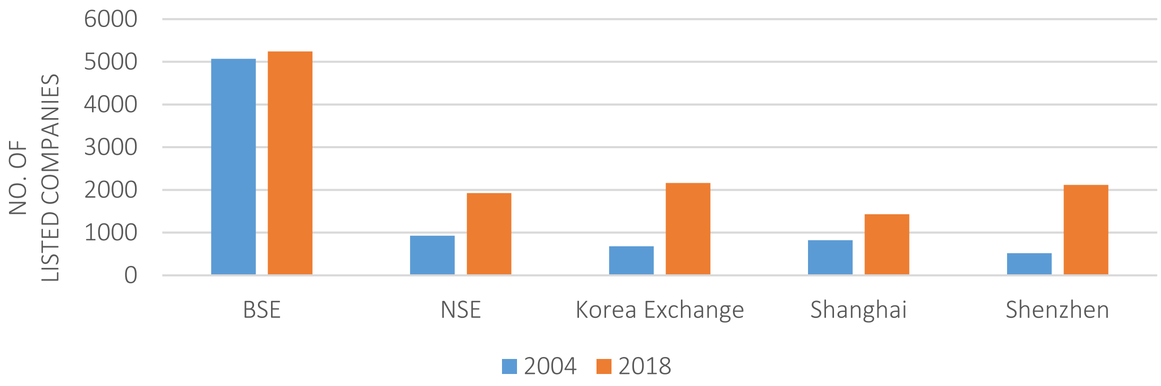

Figure 2. Platform growth: Number of companies listed on the exchanges from 2004 to 2018

Table 5. Number of shares of representative stocks on the NYSE and NSE large cap index traded in a representative trade

Quantity	NIFTY (USD) 01-FEB-2019	S&P 500, US (USD) 23-JAN-2019
AVERAGE PRICE	21.3	112.0
MEDIAN PRICE	9.6	77.2
MAX PRICE	277.1	1842.8
MIN PRICE	68.6	7.6
TURNOVER PER TRADE (50TH PERCENTILE)	439.9	10319
INR: USD, 1-FEB-2019 CLOSING	71.0	
NO. OF SHARES TRADED (MEDIAN STOCK)	45.7	133.7
NO. OF SHARES TRADED (LARGEST STOCK)	1.6	5.6

ferred in business time. It gives the time in dollars in which a unit amount of risk is transferred in the market. To understand the measure, consider the example of NYSE (12112) and NSE (412), the values for 2018. Table 5 gives the share prices of the representative large-cap equity indices of both the markets. Within the representative turnover-per-trade (50th percentile), 45.7 shares get traded of the median stock on the NSE, while 133.7 shares of the median stock get traded on the NYSE. In the representative trade, only 1.6 shares of the largest stock get traded on the NSE, while 5.6 shares of the largest share can get traded on the NYSE.

CONCLUSION

This paper provides and applies a comprehensive, microstructure-based metric (ω) for potential investors to evaluate trading venues. This measure adds the techniques already available in the literature. This novel technique presented in this paper would be useful, given the inconclusive debate on whether international diversification benefits still exist.

A rational paradigm, rooted in market microstructure theory and practice, is provided to the global asset allocators to evaluate the efficiency of exchanges around the world. The market microstructure invariance hypothesis and measures such as daily turnover-per-trade are used to examine stock exchanges and evaluate the market quality they provide. Using the extension into the invariance of trades in the exchange hypothesis, the paper shows that India's NSE, the Korea Exchange, and China's Shanghai and Shenzhen exchanges have high implicit risk when viewed in a comparative global context. When taken together with other economic and market characteristics of the key Asian exchanges, they seem to offer unique opportunities to fund managers. However, India and China are under-allocated in global portfolios.

Whether these exchanges actually accentuate market risk or merely act as a platform to transfer risk needs to be probed in further research. The paper's interpretation is that the inability to directly short equities drives traders to hedge positions in the derivatives market, if it exists with sufficient depth. This is indeed the case in India's National Stock Exchange (NSE) and the Korea Exchange, which actually have a much lower turnover in the cash equities market than in the equity derivatives market, unlike exchanges in the USA and Europe.

A further global comparison of exchanges shows that competition for order flow is seen to improve market quality in terms of the financial risk transfers. Hence, global asset allocators would benefit from the consideration of this factor when evaluating the listed markets in which to invest. The introduction of competition has improved performance on an important metric: Turnover-per-trade on a daily basis. Exchanges that enjoy monopoly power are seen to have very low Turnover-per-trade compared to peer group average. In contrast, exchanges where competition has been introduced (primarily the USA and Europe) have shown a sequential improvement towards the peer group average.

This paper adds to the literature as follows: First, it provides a rigorous yet simple and easy-to-implement set of metrics to evaluate global exchanges driven by introducing the application of the invariance of trades in an exchange hypothesis. This invariance is a novel measure of country risk that global asset managers could use. Second, it shows that diversification benefits can also come from the quality of markets and is not restricted to the risk-return paradigm alone. Third, the paper explores the impact of competition on market quality and Turnover-per-trade. Finally, it empirically demonstrates how to identify exchanges that deviate from the efficiency norm, and hence demonstrates the validity of this new measure of country risk oriented towards the needs of global long-short equity asset allocators.

AUTHOR CONTRIBUTIONS

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Formal analysis: Ranjan R. Chakravarty, Sudhanshu Pani.
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APPENDIX A

Table A1. Data sample for the year 2018

Sl no.	Stock exchange	Turnover per day (USD million)	Trades per day (no. In '000)	Turnover per trade (USD)	Quartile
1	NASDAQ – US	173928.5	15066.9	11543.7	1
2	NYSE	91397.6	7545.8	12112.4	1
3	Shenzhen Stock Exchange	31277.2	12531.3	2495.9	1
4	Japan Exchange Group Inc.	29418.1	3682.8	7987.9	1
5	Shanghai Stock Exchange	25268.8	9231.7	2737.2	1
6	BATS Chi-x Europe	17542.0	2358.8	7436.9	1
7	LSE Group	13778.1	1410.2	9770.0	1
8	Korea Exchange	10488.3	9837.8	1066.1	1
9	Hong Kong Exchanges and Clearing	9513.0	1172.8	8111.3	1
10	Euronext	8849.7	880.8	10047.6	2
11	Deutsche Boerse AG	7199.9	520.1	13844.3	2
12	TMX Group	5790.2	1095.2	5286.8	2
13	BM&FBOVESPA S.A.	4891.6	1849.0	2645.5	2
14	National Stock Exchange of India Limited	4739.1	11500.1	412.1	2
15	Taiwan Stock Exchange	3979.4	919.7	4326.6	2
16	SIX Swiss Exchange	3904.9	229.9	16982.9	2
17	Australian Securities Exchange	3881.5	1226.9	3163.6	2
18	NASDAQ Nordic Exchanges	3603.9	606.2	5945.1	2
19	BME Spanish Exchanges	2723.9	173.7	15677.9	3
20	Johannesburg Stock Exchange	1689.0	281.4	6001.7	3
21	Borsa Istanbul	1669.7	884.9	1886.9	3
22	The Stock Exchange of Thailand	1654.7	341.6	4844.0	3
23	Taipei Exchange	1096.4	265.4	4130.6	3
24	Saudi Stock Exchange (Tadawul)	933.5	100.6	9277.3	3
25	Moscow Exchange	677.8	463.3	1462.9	3
26	Oslo Bors	644.0	124.5	5174.5	3
27	Bursa Malaysia	634.2	200.0	3171.7	3
28	Indonesia Stock Exchange	599.1	386.8	1548.9	4
29	BSE India Limited	492.6	1301.2	378.5	4
30	Bolsa Mexicana de Valores	446.1	349.1	1277.8	4
31	Tel-Aviv Stock Exchange	312.5	62.4	5004.6	4
32	Warsaw Stock Exchange	243.6	76.2	3199.0	4
33	Hochiminh Stock Exchange	235.5	106.1	2219.9	4
34	Irish Stock Exchange	229.2	14.8	15464.7	4
35	Bolsa de Comercio de Santiago	225.0	18.1	12424.8	4
36	Wiener Borse	168.5	22.3	7547.4	4

Table A2. Daily turnover-per-trade with 2004 as the base year (normalized to 1)*

Stock exchange	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NASDAQ - US	1.00	0.95	0.90	0.74	1.07	0.80	1.01	1.08	1.10	1.18	1.04	1.07	1.02	1.16	1.28
NYSE	1.00	1.19	1.40	1.06	0.67	0.53	0.70	0.72	0.75	0.88	0.84	0.82	0.77	0.90	0.98
SHENZHEN STOCK EXCHANGE	1.00	0.90	1.32	2.15	1.67	1.95	2.38	2.44	2.25	2.66	3.06	3.72	2.84	2.64	2.20
JAPAN EXCHANGE GROUP INC.											1.00	0.84	0.77	0.85	0.85
SHANGHAI STOCK EXCHANGE	1.00	0.91	1.32	2.02	1.64	1.91	2.20	2.33	2.28	2.63	3.11	3.37	2.55	2.56	2.22
BATS CHI-X EUROPE					1.00	0.63	0.61	0.53	0.43	0.48	0.54	0.51	0.45	0.47	0.59
LSE GROUP						1.00	0.89	0.81	0.71	0.79	0.82	0.64	0.56	0.68	0.55
KOREA EXCHANGE					1.00	0.28	0.29	0.28	0.20	0.21	0.20	0.18	0.15	0.16	0.17

Stock exchange	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
HONG KONG EXCH. & CLEARING					1.00	0.68	0.64	0.59	0.51	0.51	0.51	0.53	0.45	0.55	0.56
EURONEXT	1.00	1.01	0.93	1.03	0.68	0.40	0.38	0.35	0.30	0.33	0.35	0.30	0.26	0.28	0.32
DEUTSCHE BOERSE AG	1.00	1.03	0.88	1.41	1.58	0.81	0.77	0.65	0.59	0.62	0.64	0.55	0.45	0.51	0.65
TMX GROUP	1.00	0.99	0.89		0.60	0.41	0.44	0.44	0.40	0.37	0.33	0.28	0.30	0.35	0.34
BM&FBOVESPA S.A.	1.00	1.38	1.64	2.75	1.96	1.23	1.29	1.00	0.70	0.54	0.42	0.28	0.28	0.35	0.34
NATIONAL STOCK EXCHANGE OF INDIA LIMITED	1.00	0.91	0.92	1.18	0.88	0.79	0.84	0.69	0.61	0.54	0.60	0.59	0.58	0.72	0.67
TAIWAN STOCK EXCHANGE	1.00	1.06	1.10	1.16	1.02	0.82	0.96	1.07	0.97	0.90	0.93	0.85	0.79	0.95	1.06
SIX SWISS EXCHANGE	1.00	0.99	0.65	0.96	0.59	0.39	0.41	0.40	0.34	0.36	0.37	0.34	0.32	0.32	0.28
AUSTRALIAN SECURITIES EXCH.	1.00	0.96	0.83	0.75	0.43	0.30	0.34	0.31	0.25	0.20	0.19	0.16	0.13	0.12	0.11
NASDAQ NORDIC EXCHANGES		1.00	0.70	0.85	0.55	0.33	0.26	0.23	0.19	0.22	0.22	0.18	0.15	0.15	0.14
BME SPANISH EXCHANGES		1.00	0.70	0.94	0.72	0.56	0.45	0.37	0.29	0.26	0.22	0.19	0.15	0.16	0.17
JOHANNESBURG STOCK EXCH.	1.00	0.94	0.76	0.90	0.57	0.40	0.43	0.42	0.38	0.26	0.20	0.15	0.14	0.15	0.15
BORSA ISTANBUL			1.00	1.25	1.18	0.92	1.05	0.83	0.97	1.11	1.01	0.82	0.64	0.54	0.39
THE STOCK EXCHANGE OF THAILAND	1.00	0.93	0.88	1.15	0.95	0.90	1.28	1.31	1.18	1.20	0.96	0.81	0.91	0.98	1.18
TAIPEI EXCHANGE									1.00	1.03	1.21	1.13	1.11	1.22	1.39
SAUDI STOCK EXCH. (TADAWUL)						1.00	1.12	1.24	1.32	1.36	1.73	1.57	1.23	1.10	1.00
MOSCOW EXCHANGE									1.00	0.86	0.68	0.38	0.36	0.38	0.40
OSLO BORS	1.00	1.00	0.85	1.05	0.63	0.36	0.36	0.27	0.18	0.18	0.16	0.13	0.12	0.12	0.12
BURSA MALAYSIA			1.00	1.37	2.09	1.46	1.84	1.80	1.84	1.77	1.39	1.04	0.99	1.01	0.95
INDONESIA STOCK EXCHANGE	1.00	1.41	1.11	1.30	1.13	0.62	0.68	0.67	0.54	0.53	0.32	0.26	0.29	0.25	0.21
BSE INDIA LIMITED	1.00	1.16				0.84	0.88	0.71	0.59	0.47	0.61	0.59	0.53	0.95	0.71
BOLSA MEXICANA DE VALORES	1.00	1.03	1.21	1.08	0.77	0.36	0.45	0.35	0.21	0.16	0.13	0.08	0.06	0.06	0.04
TEL-AVIV STOCK EXCHANGE	1.00	1.02	0.94	1.13	1.43	0.82	0.84	0.86	0.70	0.75	0.78	0.68	0.67	0.68	0.71
WARSAW STOCK EXCHANGE	1.00	1.44	1.12	1.30	1.61	0.99	1.35	1.48	1.19	1.35	1.16	0.79	0.65	0.77	0.72
HOCHIMINH STOCK EXCHANGE										1.00	1.24	1.23	1.30	1.49	1.32
IRISH STOCK EXCHANGE	1.00	1.11	0.17	1.04	0.43	0.21	0.19	0.13	0.13	0.15	0.12	0.11	0.10	0.11	0.10
BOLSA DE COMERCIO DE SANTIAGO	1.00	1.08	1.52	1.73	1.51	1.30	1.07	0.91	0.83	0.78	0.54	0.29	0.27	0.30	0.44
WIENER BORSE	1.00	1.91	1.72	1.55	1.14	0.67	0.68	0.57	0.45	0.44	0.45	0.35	0.31	0.37	0.50

Note: * Demonstrates how competition lowers the turnover-per-trade.

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