The efficient market hypothesis: Evidence from ten African stock markets

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1. INTRODUCTION

Since the work by Fama (1965, 1970), the efficient market hypothesis (EMH) has become a central part of finance theory. The vast body of research done around this concept is evidence of the interest that the EMH has drawn in both the investment and academic circles. However, the bulk of this evidence is from developed markets in the United States and Europe (Groenewold and Ariff, 1998; Mobarek and Keasey, 2000). Little is known about the efficiency of emerging markets, especially those in Africa. The studies available on African stock markets mostly made use of indices data. This is more so in studies that have included more than one market (e.g., Appiah-Kusi and Menyah, 2003).

The majority of studies relating to market efficiency with respect to African stock markets have been conducted on the Johannesburg Stock Exchange (JSE). Smith *et al*. (2002), Smith and Jefferis (2002) and Magnusson and Wydick (2002), among others, found the JSE to be weak-form efficient. Appiah-Kusi and Menyah (2003), however, concluded on the contrary that the JSE is not weak-form efficient for the period 1990 to 1995, using weekly data.

Appiah-Kusi and Menyah (2003) found the stock markets of Botswana, Ghana and the Ivory Coast not to be weak-form efficient for the respective periods investigated[1]. The findings for Ghana and Botswana are consistent with those by Magnusson and Wydick (2002) who found the two markets not to conform to random walk 3 and random walk 2, respectively. Appiah-Kusi and Menyah (2003) concluded that Kenya, Zimbabwe, Egypt, Morocco and Mauritius are weak-form efficient[2]. Kiweu (1991) and Dickinson and Muragu (1994) reached the same conclusion for Kenya, for the periods 1986 to 1990 and 1979 to 1988, respectively, while Chiwira (2001) found the Zimbabwe Stock Exchange to be weak-form efficient for the period 1995 to 1999. Smith *et al*. (2002) concluded, on the contrary, that Egypt, Morocco and Mauritius are not weak-form efficient for the periods January 1990 to August 1998 for Morocco and Mauritius, and January 1993 to August 1998 for Egypt. Bundoo (2000) reached the same conclusion for the Stock Exchange of Mauritius (SEM) for the period 1992 to 1998. Asal (2000) also found the Egyptian Stock Exchange to be weak-form inefficient for the period 1992 to 1996, although he suggested that it was moving towards efficiency in 1997.

Studies that have used data on individual stocks used either monthly or weekly data rather than daily data. The limiting factor, among others, as pointed out by Dickinson and Muragu (1994), has been the non-availability of computerised databases. The other argument for using data measured over longer time intervals is the problem of thin-trading. Increasing the time interval is argued to reduce the potential biases associated with thin-trading by increasing the probability of having at least one trade in the interval (Dickinson and Muragu, 1994). The trade, most probably, would not have taken place at the end of the interval. The result of this is what Bowie (1994) referred to as the "price age"[3] component. This component of thin-trading, though more critical in long time horizons, is usually ignored.

Although some studies on African stock markets have acknowledged the thin-trading problem, very few have gone beyond mere acknowledgement of the existence of the problem. The limited studies that tried to address the thin-trading problem include Asal (2000) on the Egyptian Stock Exchange and Appiah-Kusi and Menyah (2003) on eleven African stock markets. Both studies used the adjustment method by Miller, Muthuswany and Whaley (1994) for index returns.

This paper studies the weak-form efficiency of ten African stock markets using the serial correlation and runs tests. To address the problem of thin-trading, returns are calculated on a trade-to-trade basis and adjusted for variability in the interval lengths. This adjustment is done by weighting the trade-to-trade returns by the number of days between trades (see Mlambo, Biekpe and Smit, 2003).

The rest of the paper proceeds as follows. Section 2 gives a general overview of African stock markets.

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[1]The periods investigated were 1989 to 1995 for Botswana, 1990 to 1995 for Ghana and 1992 to 1995 for the Ivory Coast.

[2]For Kenya and Zimbabwe, the periods investigated were 1990 to 1995, while for Morocco it was 1990 to 1994, Mauritius 1989 to 1995 and Egypt 1993 to 1995.

[3]"Price age" is defined as the time that lapses between the last trade in a given period and the end of that period. This price age factor is important in that when a share is not traded at the end of a given time interval, then the price at which the share was last traded is incorrectly taken to be the price at the end of the interval under perspective.

Section 3 describes the data and methodology used. Section 4 presents and discusses the empirical results while section 5 summarises and concludes the paper.

2. AN OVERVIEW OF AFRICAN STOCK MARKETS

2.1 The emergence

About two-thirds of African stock markets emerged in the late 1980s and early 1990s (Mlambo and Biekpe, 2001; Moss, 2004). The latest arrival is the Douala Stock Exchange in Cameroon, which was established in 2003, making it the youngest stock market on the African continent. Most of these markets were formed at the instigation of government to act as vehicles to privatise state-owned enterprises (Mlambo and Biekpe, 2001; Moss, 2004). This is contrary to misconceptions in some circles that donor agencies, in particular the World Bank and International Monetary Fund, are the driving forces behind the establishment of stock markets in Africa.

African stock exchanges are also the smallest in the world in terms of both number of listed stocks and market capitalisation (see Table 1). They are also small relative to their economies, with the market capitalisation of the Nigerian Stock Exchange only representing 8 percent of gross national product (GNP), while in the case of Zimbabwe, Kenya and Ghana, the market capitalisations ranged from 25 percent to 35 percent of GNP (Kenny and Moss, 1998). The largest African stock market in terms of market capitalisation is the JSE (Table 1). According to Senbet (2000), the market capitalisation of the JSE is ten times the combined capitalisation of the rest of Africa's stock markets and over 100 times their average. Of the more than 2 000 firms listed on Africa's stock exchanges, the majority are listed on Egypt's Cairo and Alexandria Stock Exchanges (CASE), although only a small percentage of these are actively traded.

2.2 Trading times and trading systems

The majority of stock markets in Africa trade daily, from Monday to Friday (Sunday to Thursday in Egypt), except for a few such as Ghana[4], Tanzania, and Uganda, which, in 2002 were trading three times a week. Ghana was trading on Monday, Wednesday and Friday, while Tanzania and Uganda were trading on Tuesday, Wednesday and Thursday (see Table 2). Trading times also vary, ranging from one hour per trading day in Tanzania to the whole business day from 08h00 to 16h30 in Zimbabwe (see Table 2).

Trading methods on African stock exchanges vary from open-outcry to call-over to electronic trading systems (Table 2). The Nigerian stock market has replaced the call-over trading system with the automated trading system (ATS). Clearing, settlement and delivery of transactions on the exchange are now done electronically by the Central Securities Clearing System (CSCS). Following the closure of the open-outcry trading floor in June 1996, the JSE introduced an order driven, centralised, automated trading system known as the JSE Equities Trading (JET) system. In May 2002 the JET system was converted to the Stock Exchange Trading Systems (SETS) used on the London Stock Exchange (LSE). SETS is a world-class, flexible and robust trading platform that promise improved liquidity and ensure more efficient functionality. SETS also allows South African based companies access to offshore privileges without having to move offshore. Other markets that adopted the JSE's trading system include Ghana and the Namibia Stock Exchanges.

Migration from an open outcry to an electronic trading system on the Casablanca Stock Exchange (CSE) took place between 4 March 1997 and 15 June 1998. All securities quoted on the CSE are now traded on the electronic trading system. Orders entered by dealers are automatically sorted by price limit and in chronological order, in the "market order book". On the central market, the less liquid securities are quoted on a call auction or fixing basis (once per session). The more liquid securities are quoted on a continuous basis. The electronic trading system automatically downloads to a market information system. This means that data providers can receive real-time market data (time, price, number of shares traded, etc), just as it appears on the dealers' screens.

2.3 Trading costs, foreign investment and capital flows restrictions

The sudden supply of vast amounts of mobile capital in the early 1990s created an environment conducive for the emergence of stock markets in Africa. However, up until now, portfolio inflows to Africa have been disappointing. One possible reason for this unfavourable scenario is that the acquisition of shares by foreigners is limited on some African stock markets (see Table 3). The prohibitive institutional barriers, trading costs, and factors such as foreign exchange risk, political risk and informational and institutional barriers, act as disincentives to foreign portfolio investments. Some African stock markets still operate in regulatory environments with restrictive capital flow controls on the remittance of capital, capital gains, dividends, interest payments, returns and other earnings (Mlambo and Biekpe, 2001).

[4]Ghana is now trading daily as from 2004.

Table 1: Age and size of African stock markets

Stock Exchange	YEAR 2000 STATISTICS						YEAR 2002 STATISTICS			Main stock exchange index
	Year formed	Mkt Cap (US$'m)	Mkt Cap (%GDP)	No. of firms listed	Value traded (%GDP)	Turn-over ratio (%)	Mkt Cap (US$'m)	Value traded (US$'m)	No. of firms listed	
Algeria		-	-	-	-	-	145	0	3	LA All Share
Botswana	1989	978	18,497	16	0,895	4,78	1 717	62	19	BSE Domestic
Cameroon (Doula)	2003	-	-	-	-	-	-	-	-	-
Cote d'Ivoire (Abidjan)	1974	-	-	-	-	-	-	-	-	-
Cote d'Ivoire (BRVM)	1998	1185	12,650	41	0,355	2,59	1 329	16	38	BRVM 10
Egypt (Cairo & Alexandria)	1903, 1888	28741	29,112	1076	11,264	34,74	26 245	7 362	1151	CMA General
Ghana	1989	502	9,680	22	0,195	1,48	382	11	24	GSE All Share
Kenya (Nairobi)	1954	1283	12,389	57	0,458	3,58	1 676	36	50	NSE 20 Share
Malawi (Blantyre)	1996	-	-	-	-	-	107	3	8	MSE Domestic Share
Mauritius (Port Louis)	1989	1331	30,383	40	1,722	5,01	1 324	59	40	SEMDEX
Morocco (Casablanca)	1929	10899	32,686	53	3,280	9,22	8 319	922	56	Morocco All Share
Mozambique (Maputo)	1999	-	-	-	-	-	-	-	-	-
Namibia	1992	311	8,945	13	0,634	4,51	201	129	13	NSX Local Companies
Nigeria	1960	4237	10,313	195	0,640	7,29	5 989	486	195	NSE All Share
South Africa (Johannesburg)	1887	204952	162,806	616	61,558	33,9	182 616	76 792	472	JSE All Share
Sudan (Khartoum)	1994	-	-	-	-	-	-	-	-	-
Swaziland	1990	-	-	-	-	-	146	0	5	SSX All Share
Tanzania (Dar es Salaam)	1998	181	2,100	4	0,100	3,4	695	19	5	LA All Share
Tunisia (Tunis)	1969	2828	14,529	44	3,215	23,29	1 810	704	46	TUNINDEX
Uganda	1997	-	-	-	-	-	52	1	3	LA All Share
Zambia (Lusaka)	1993	291	9,200	8	0,400	4,7	231	2	11	LuSE All Share
Zimbabwe	1896	2432	32,906	69	3.776	10,77	11 689	131	77	ZSE Industrial

Source: World Development Indicators 2002, 2002

In Malawi, for example, the Reserve Bank of Malawi (RBM) manages the exchange control. Foreign investment capital, whether in the form of equity or loans, needs to be registered with the RBM. Foreign loans and equity investments, the remittance of dividends and capital, among other transfers, require permission from the RBM. In the case of Mozambique, remittance of funds overseas is restricted. Foreign investors can remit loan repayments, dividends and capital if permission has been obtained for amounts above US$5000. In Zimbabwe, dividend remittances in respect of projects approved by the Zimbabwe Investment Centre are allowed at 100 percent of after tax profits. Capital is blocked and may be remitted through 20-year 4 percent government bonds, denominated in Zimbabwean dollars. Capital is paid in 10 equal annual instalments at the end of years 11 to 20.

In some countries such as Botswana, Mauritius, Zambia and Uganda, there are no foreign exchange controls. Profits, dividends and capital can be freely repatriated. In Ghana, the financial regime is relatively flexible and allows the free transfer of foreign currency in and out of Ghana. A foreign investor may, subject to approval, operate a foreign currency account with banks in Ghana. In Kenya, the Foreign Investment Protection Act guarantees that foreign investors can convert and repatriate capital freely. The Exchange Control Act was repealed in 1995, removing the last of the restrictions on profit remittances and borrowing.

Namibia, as part of the Common Monetary Area (CMA) with South Africa, Swaziland and Lesotho, has unrestricted capital flows for non-residents. Capital, profits and dividends can be repatriated. Exchange control limitations do apply to resident capital flows. South Africa has adopted the approach of gradually abolishing exchange controls. Restrictions on non-resident capital flows were fully liberalised with the abolition of the financial Rand in 1995. Restrictions on residents are gradually being relaxed. In Swaziland, there are no foreign exchange restrictions between CMA members. However, exchange controls between CMA members and the rest of the world may not be less strict than those of South Africa.

Table 2: Trading arrangements on African stock markets, 2002

Stock Exchange	Website	Trading days	Trading hours	Trading method	Clearing & Settlement	Settlement Cycle
Algeria	www.cosob.com.dz	Mon	09h30 to 11h10	Automated trading system (ATS)	Electronic	T+4
Botswana	www.bse.bw	Mon to Fri	09h00 to 09h30 & 15h00 to 15h30	Call-over system with presiding officer	Manual, T by T[#]	T+5
Cameroon (Douala)		N/A	N/A	N/A	N/A	N/A
Cote d'Ivoire (Abidjan)	Closed	Closed	Closed	Closed	Closed	Closed
Cote d'Ivoire (BRVM)	www.brvm.org	Mon to Fri	10h45 to 12h00	electronic fixing or computerised trading system	n.a.	T+5
Egypt (Cairo & Alexandria)	www.egyptse.com	Sun to Thurs	11h30 to 15h30	Electronic order-driven or computer based trading with automated matching	Manual, T by T	T+4
Ghana	www.gse.com.gh	Mon, Wed, & Fri	10h00 to 13h00	Call-over with a limited auction	Manual, T by T	T+5
Kenya (Nairobi)	www.nse.co.ke	Mon to Fri	10h00 to 12h00	Open outcry, continuous order-driven system	Manual, T by T	T+5
Malawi (Blantyre)	www.mse.co.mw	Mon to Fri	09h00 to 12h00	Call-over floor-based system	T by T	T+7
Mauritius (Port Louis)	www.semdex.com	Mon to Fri (Official); Tues & Thurs (OTC)	10h00 to 11h00 (Official); 14h00 to 15h00 (OTC)	Screen-based ATS; order-driven and single price auction	Automated, Strict Delivery versus Payment	Rolling T+3
Morocco (Casablanca)	www.casablanca-bourse.com	Mon to Fri	08h30 to 12h30	ATS	Manual, T by T	T+3
Mozambique (Maputo)		-	-	-	-	-
Namibia	www.nsx.com.na	Mon to Fri	09h00 to 16h00 (summer) 08h00 to 15h00 (winter)	Computer-based ATS JSE Equity Trading System (JET)	Manual, T by T	T+5 rolling
Nigeria	www.thenigerianstockexchange.com	Mon to Fri	From 11h00 until all bids are done	Automated computer-based auction system	Delivery Versus Payment netting off process.	T+3
South Africa (Johannesburg)	www.jse.co.za	Mon to Fri	09h00 to 16h00	JET order-driven, continuous auction on a trading floor	Electronic-STRATE	Rolling T+5
Sudan (Khartoum)		-	-	-		
Swaziland	www.ssx.org.sz	Mon to Fri	10h00 to 12h00	Call-over floor-based system	T by T	T+5
Tanzania (Dar es Salaam)	www.darstock.com	Tue, Wed, Thurs	10h00 to 11h00	Open outcry auction system	Electronic, transaction-by-transaction	T+5
Tunisia (Tunis)	www.bvmt.com.tn	Mon to Fri	09h00 to 12h30	Electronic order-driven (liquid stocks). Fixing basis (less liquid stocks)	Automatically	T+5
Uganda	www.ugandacapitalmarkets.co.ug	Tue to Thurs	10h00 to 12h00	Call-over floor-based system	T by T	T+5
Zambia (Lusaka)	www.luse.co.zm	Mon to Fri	10h00 to 11h00 (1st session) 12h00 to 13h00 (2nd session)	Single price auction, order-matching	Automated	T+3
Zimbabwe	www.zse.co.zw	Mon to Fri	08h00 to 16h30	Call-over, floor-based system	T by T	T+7

[#] T by T: Transaction by transaction
Sources: Stock exchange websites

Table 3: Trading costs and foreign investment restrictions

Stock Exchange	Market regulator	Withholding taxes			Commission rates	Foreign Investment Ceilings	
		Interest	Dividends	Capital gains		Individual	Collectively
Algeria	Commission d'Organisation et de Surveillance des Opérations de Bourses (COSOB)	None	None	None	-	No restrictions	
Botswana	The Botswana Stock Exchange Committee	15%	15%	None	1% to 2%	5%	49%
Cameroon (Doula)	-	-	-	-	-	-	-
Cote d'Ivoire (Abidjan)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cote d'Ivoire (BRVM)	Conseil Régional de l'Epargne Publique et des Marchés Financiers (CREPMF)	None	10%	None	-	No restrictions	
Egypt (Cairo & Alexandria)	Capital Markets Authority	15%	None	None	No fixed rates	No restrictions	
Ghana	Securities Exchange Commission	15%	10%	None	1% to 2,5%	10%	74%
Kenya (Nairobi)	Capital Markets Authority	15%*	5%*	None	1,1% to 2%	5%	40%
Malawi (Blantyre)	The Stock Exchange Committee	20%**	None	35%**	1% to 2%	10%	49%
Mauritius (Port Louis)	Financial Services Commission	None	None	None	0,9% to 1,25%	Open to foreign investors	
Morocco (Casablanca)	Conseil Deontologique des Valeurs Mobilieres. (CDVM)	10%	None	None	0,6%–0,3%	No restrictions	
Mozambique (Maputo)	-	-	-	-	-	-	-
Namibia	NA	10%	None	None	0,35% to 1,1%	No restrictions. However, needs Central Bank approval to take over a bank	
Nigeria	Securities and Exchange Commission	10%	10%	None	1% to 2,75%	No restrictions	
South Africa (Johannesburg)	Financial Services Board	Based on marginal tax rates			1,2%–0,2%	15% (banks), 25% (insurance companies)	
Sudan (Khartoum)	-	-	-	-	-	-	-
Swaziland	Capital Markets Development Unit	10%	15%	None	1% to 2%	No restrictions	
Tanzania (Dar es Salaam)	Dar-es-Salam Stock Exchange	5%	5%	None	1,1% to 2%	Closed to foreign investors	
Tunisia (Tunis)	Conseil du Marché Financier	None	None	None		49.9% in general	
Uganda	Capital Markets Authority (CMA)	15%	15%	None	1,1% to 2%	No restrictions	
Zambia (Lusaka)	The Securities and Exchange Commission (SEC)	15%	15%	None	fixed 0,25%	No restrictions	
Zimbabwe	ZSE Committee	10%	15%	10%	1% to 2%	10%	40%

*These are for residents only. For non-residents the tax rates are 12.5% on interest and 7.5% on dividends
**Also for residents. For non-residents the tax rates are 15% on interest and 35% on capital gains
Source: Stock exchange websites

In Tanzania, foreign exchange controls were removed through the Foreign Exchange Act of 1992. Capital transfers are however still subject to approval by the Bank of Tanzania. Profits and dividends can be fully repatriated. In Nigeria, foreign investors are guaranteed unconditional transfer of their capital and profits. Importation or exportation of foreign exchange above US$5 000 is declared. A domiciliary account can be opened in foreign currency at banks and cash withdrawals from such accounts are permissible. For

purposes of exchange control and monitoring the flow of foreign currencies, authorised dealers are required to inform the central bank whenever transfers larger than US$10 000 are made into a domiciliary account.

2.4 The market regulator

Some of the African stock markets were established on the back of poor regulatory and legislative frameworks. This, among other things, explains why some of these markets lack the capacity to deal with capital market dynamics. Legislations to prevent insider trading are either inadequate or non-existent, and where they exist, enforcement is often poor. The inadequacy of insider trading laws on African stock markets has enhanced the perception that these markets are not efficient. Insider trading has been one of the problems historically faced by the JSE. South Africa is one of the countries in Africa with insider trading laws. However, no prosecution for insider trading has taken place in South Africa due to the inadequacy of the legislation and the existence of lax and unenforceable laws.

The successful integration of African markets into the world financial system requires regulatory frameworks that conform to international standards. An appropriate legal and regulatory framework, sufficiently monitored, is a necessity to protect investors and the integrity of the markets. It also helps to instil confidence, a sense of fairness and financial discipline in the market. In most countries the regulator is a government agency, the central bank, finance ministry or an independent commission (see Table 3). In some countries, the capital market is accorded regulatory powers to become a self-regulatory body, or the power to regulate is a shared responsibility between two or more agencies.

2.5 Market microstructures

African stock markets are also known to be illiquid and characterised by thin trading (Mlambo and Biekpe, 2005), in comparison to stock markets in other regions. According to Kenny and Moss (1998), 8 of the world's 12 most illiquid stock exchanges in 1995 were in Africa.

Expected annual volatility is also, on average, high on the African markets. In Erb, Harvey and Viskanta. (1996), volatility was an average 35,6 percent on African markets compared to 21,4 percent for the Morgan Stanley Capital International (MSCI) developed equity markets, measured using the countries' risk ratings. Kenny and Moss (1998) suggested that this extreme volatility is a result of the small size nature, lack of liquidity and, often, unstable political and economic environments. The higher expected volatilities on the African stock markets, implying higher risk, however, also imply higher expected returns as compensation for the risk. Erb*, et al.* (1996) found the average expected return for Africa to be quite high at 18,4 percent. The ability of African markets to attract investors, despite the high risks, rests upon the relatively higher returns these markets potentially give on investments.

African stock markets lack integration with world equity markets and also with each other. Erb*, et al.* (1996) found the average correlation of African stock markets with world equity markets to be a low 0,05 percent. The segmentation of African markets implies that investors demand compensation in the form of higher expected returns for their risk exposure. However, the lack of integration of African stock markets with global equity markets make them potentially good portfolio diversifiers. African markets, except the JSE, were not affected by the Asian crisis due to the lack of interdependence with other global emerging markets (Collins and Biekpe, 2001).

2.6 The delay to regional integration

A stock market is perceived by African governments to be an indication of integration into the global economy. It is considered to be a sign of international legitimacy and a measure of a country's modernisation and commitment to private sector-led development (Moss, 2004). Therefore, the emergence of stock markets on the African continent seems more like an explicit response by African governments to globalisation and a desire to be included. In Africa, a stock market is regarded as a symbol of national prestige and progress, similar to a national airline, or a mark of sovereignty, similar to flags or national anthems (Turner, 1999). According to Moss (2004), both the national airline and the stock exchange serve very important symbolic and practical purposes, yet they come at a cost that may not rationally justify their existence.

The symbolic significance of a stock market to African governments has contributed to the lack of progress in integrating regional stock exchanges. The critical prohibiting factor is location. The African Stock Exchange Association (ASEA) has a long-term plan to consolidate the various national stock exchanges into regional hubs based in Johannesburg, Nairobi, Abidjan, Lagos and Cairo. According to Mlambo and Biekpe (2001), an integrated real time network for SADC stock exchanges was expected to be up and running by the year 2006 but it has not yet materialised. The only regional stock exchange in Africa, the Bourse Régionale des Valeurs Mobilières (BRVM) was made possible by the fact that Cote d'Ivoire had been the only West African franc zone member country with a Stock Exchange and Abidjan was by far the main commercial centre in the zone. Even though Gabon was pushing to have the exchange located in its capital Libreville, the other members resisted, with each of them wanting to play host (Moss, 2004). The BRVM serves the 8 French-

speaking member countries of the West African Economic and Monetary Union (UMOEA), namely Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo.

The problem of location is not only with regional stock exchanges but national stock exchanges as well. The Nigerian Stock Exchange (NSE) was established as the Lagos Stock Exchange in 1960. When the government moved offices to Abuja in 1991, there were fears that the newly privatised enterprises might still use Lagos as their headquarters instead of moving to the new capital, Abuja. Therefore, propositions were made to open another stock exchange in Abuja and a branch of the NSE was recently opened there. If Africa could embrace Information Technology, a physically existing brick-and-mortar exchange trading floor would become less significant as the trend is moving towards electronic trading. Therefore, the issue of location will inevitably be resolved. Electronic trading will also encourage liquidity and efficiency, two characteristics that have been lacking on the African stock markets.

3. DATA AND METHODOLOGY

The markets studied in this paper are Egypt, Kenya, Zimbabwe, Morocco, Mauritius, Tunisia, Ghana, Namibia, Botswana and the West African Regional Stock Exchange (Bourse Regionale des Valeurs Mobilieres - BRVM) in Cote d'Ivoire.[5] The data used in this study are daily closing stock prices and volume traded for individual stocks. The data for Egypt, Kenya, Zimbabwe, Morocco and Mauritius were obtained from DataStream and comparisons were made with samples from the respective stock exchanges and/or stockbrokers (e.g. the Nairobi Stock Exchange for Kenya, Casablanca Stock Exchange for Morocco, BARDNET and Kingdom Stockbrokers for Zimbabwe) to determine reliability and accuracy.

For Botswana, Namibia and the BRVM, the data were obtained from the respective stock exchanges while for Ghana and Tunisia at least two sources were consulted. These are Tunisie Valeurs, Tustex and Financiere de Placement et de Gestion (FPG) for Tunisia; Databank and SDC Brokerages for Ghana. For all the markets in the study, volume traded data were obtained and used to determine the trading frequencies and durations of non-trading of the different stocks. A stock is included in the sample as long as it has been listed for the entire period under consideration; it has not been part of an acquisition or merger during the period under review; it has not been suspended from trade for a period longer than a week; and it has enough data points to make a meaningful analysis. The period examined for each market is shown in Table 4, which also shows the thin-trading[6] frequencies for each market.

As can be seen from Table 4, the markets in this study exhibit serious thin-trading for the periods under investigation. For Namibia, the lowest thin-trading frequency is 62%. If such a thin-trading frequency is considered serious, then all the stocks in the Namibian sample can be said to have serious thin-trading. Other relatively thin-traded markets are Botswana with the lowest thin-trading frequency of 34% and Mauritius with 14%. Interestingly, most of the stocks on the Namibian and Botswana stock exchanges have dual listings on the JSE. Probably, trading in these stocks takes place more on the JSE than on these other markets. Because the majority of stocks on the Namibian Stock Exchange (NSX) are dual-listings on the JSE (68% of stocks in our sample), the NSX is usually not open for trade whenever there is a holiday in South Africa.

This paper uses continuously compounded returns calculated on a trade-to-trade basis and adjusted for interval variability, following Mlambo *et al*. (2003)[7]. According to Mlambo and Biekpe (2005), the conclusion on whether a market is efficient or not is subject to the methodology used, especially in adjusting for the thin-trading effect. Bowie (1994) argued in favour of the trade-to-trade approach in measuring stock returns on a thinly traded market.

[5]Although the markets were selected according to data availability the JSE is excluded from the sample of African stock markets studied here because of its large size of around 80% of total market capitalisation of African stock markets in aggregate, which put it in a league of its own and will thus be better categorised with the emerging markets of Asia and Latin America. The second largest African stock market in terms of market capitalisation is Egypt, which is about 11% of the total African stock markets capitalisation. Again South Africa has been relatively widely researched in comparison with the other African stock markets. The intention of this study was to bring more focus on those markets but have lingered in the background of the limelight.

[6]The thin-trading referred to here is rather non-trading, whereby a stock does not trade every consecutive interval. On the other hand is non-synchronous trading, whereby a stock can trade every consecutive interval but not necessarily at the end of the interval. The focus on the former is because the later requires historical prices for periods shorter than a day and these data are not available for most African stock markets. Most of the markets only open for a few hours in a day and non-trading, without considering non-synchronous trading, is, in itself, a very big problem.

[7]Each trade-to-trade return is 'weighted' by the interval length, which in this case is the number of days between trades. This does not mean getting averages and allocating them to each of the days within a trading period as might be incorrectly interpreted. In fact only the day when there was trade is considered and all the days not traded are ignored or left out.

Table 4: Data and thin-trading properties

Stock Exchange	Year Established	Data Sampling period*	# Trading days	Sample size	Sample thin-trading frequency			
					range	median	average	std dev
Botswana	1989	23 Mar 98 - 31 May 02	1035	12	34-94%	73%	69%	0,21
BRVM	1998	04 Jan 99 - 31 Dec 02	687	24	03-95%	65%	65%	0,22
Egypt	1888/1903	02 Jan 97 - 31 May 02	1342	54	05-74%	18%	29%	0,24
Ghana	1989	02 Jan 98 - 30 Dec 02	753	20	10-87%	70%	58%	0,25
Kenya	1954	02 Jan 97 - 31 May 02	1366	40	02-97%	53%	49%	0,30
Mauritius	1989	01 Jun 98 - 31 Dec 02	1197	9	14-52%	29%	31%	0,14
Morocco	1929	02 Jan 97 - 31 May 02	1349	36	01-97%	49%	45%	0,33
Namibia	1992	02 Jan 97 - 31 May 02	1341	15	62-98%	87%	85%	0,10
Tunisia	1969	02 Jan 98 - 31 Dec 02	1250	35	02-91%	32%	39%	0,31
Zimbabwe	1896(1946)	02 Jan 97 - 31 May 02	1353	39	04-94%	49%	51%	0,23

Notes: *The variability in the sampling periods is due, among other reasons, to the availability of the data. The BRVM, for example, was established towards the end of 1998 and thus the data series could only start after 1998. Mauritius, though established in 1989, changed to daily trading in 1998 and therefore this period was chosen so as not to distort the data series. The Botswana Stock Exchange only started recording transactions data on a daily basis in March 1998 when it introduced the computerised trading system. A large number of stocks were listed on the Tunisian Stock Exchange after the introduction of electronic trading in 1997 and thus the choice of this starting date. For Ghana it was difficult to access data prior to 1998.
Thin-trading frequency is measured as the number of days a stock does not trade out of the total number of days the stock exchange was open for trade for the period studied. A thin trading frequency of 62% would imply a stock not trading in 62 out of every 100 trading days.

The adjusted trade-to-trade returns are calculated as follows:

$$\tilde{R}_t = \frac{1}{K_t}\left[\ln(P_t) - \ln(P_{t-K_t})\right] \quad \ldots (1)$$

where:

$\tilde{R}_t$ is the trade-to-trade return adjusted for the interval effect

P_t is the stock's traded price in period *t*

P_{t-K_t} the price of a stock K_t periods in the past

K_t is the length of time (in days) between the trade in period *t* and the previous successive trade

However, even when returns are calculated on a trade-to-trade basis, there is still a high prevalence of zero returns (see Table 5). This implies that in most cases stocks changed hands without having an impact on the stock prices. For Ghana, between 57 percent and 82 percent of the trade-to-trade returns are zero returns, while for the BRVM the trade-to-trade zero returns range from 43 percent to 85 percent of the total returns calculated. Only Egypt has relatively low percentages of trade-to-trade zero returns ranging from 2 percent to 23 percent of the trade-to-trade returns calculated.[8] These zero returns are likely to lead to positive serial correlation in the return series. Therefore, the trade-to-trade approach will only reduce, but not eliminate, the bias on our findings towards the rejection of serial independence.

4. EMPIRICAL RESULTS

The returns were tested for normality and all the stocks rejected the normality assumption using the Kolmogorov-Smirnov test at the 1% level of significance. Due to the non-normality of the returns series, a nonparametric measure for independence, that is, the runs test, is used. This test is not affected by any extreme values in the return series (Dickinson and Muragu, 1994) and thus does not require constant variance of the data (Barnes, 1986). The hypothesis of independence is tested using the significance of the standardised Z-values at the 5% level of significance. This statistic compares the observed and expected number of runs. The observed number of runs is the sequences of price changes of the same sign. The total expected number of runs (*m*) is computed as follows, (see Fama, 1965):

$$m = \frac{n(n+1) - \sum_{i=1}^{3} n_i^2}{n} \quad \ldots (2)$$

where *n* is the total number of price changes and n_i (*i* =1,2,3) are the numbers of price changes of each sign - positive, negative and zero.

[8]However, it is important to note that for Egypt, the stocks included in the sample are the most actively traded and the sample size is slightly less than 5 percent of the total number of stocks listed on this market.

Table 5: Analysis of zero returns

Country/ Stock Exchange	Stock market trading days	Days actually traded	Zero returns (%)	'True' zero returns (%)
Botswana	1035	65 to 677	81 to 85	9 to 71
BRVM	687	34 to 664	55 to 98	43 to 85
Egypt	1342	345 to 1277	6 to 78	2 to 23
Ghana	753	143 to 684	65 to 94	57 to 82
Kenya	1366	38 to 1338	31 to 98	21 to 45
Mauritius	1197	575 to 1033	56 to 76	46 to 56
Morocco	1349	33 to 1336	22 to 98	18 to 39
Namibia	1341	31 to 503	55 to 97	9 to 61
Tunisia	1250	107 to 1226	18 to 94	15 to 72
Zimbabwe	1353	81 to 1293	40 to 86	31 to 49

Stock market trading days: These are made up of the number of days a stock exchange was open for trade for the period under investigation
Days actually traded: These are the number of days when trade took place for each stock
Zero returns: These are the number of days recording a zero return for each stock as a proportion of the number of days the respective stock exchange was open for trade, and are thus recorded as percentages.
'True' zero returns: These are the number of days recording a zero return for each stock when the stock actually traded or changed hands as a proportion of the number of days trade actually took place for the stock. Also given in percentages

According to Fama (1965), for large *n*, the distribution of *m* is approximately normal and the Z-value is calculated as follows:

$$Z = \frac{r + \frac{1}{2} - m}{\sigma_m} \quad \ldots (2)$$

where *r* is the observed number of runs, the "½" is the discontinuity adjustment factor and σ_m is the standard error of *m* and is given by:

$$\sigma_m = \left(\frac{\sum_{i=1}^{3} n_i^2 \left[\sum_{i=1}^{3} n_i^2 + n(n+1) \right] - 2n \sum_{i=1}^{3} n_i^3 - n^3}{n^2 (n-1)} \right)^{\frac{1}{2}} \quad \ldots (3)$$

where all the variables are as defined before

A negative Z-value implies that the observed number of runs is less than the expected number of runs and thus positively correlated. The opposite is true for a positive Z-value.

The majority of stocks for Ghana and Mauritius rejected the random walk hypothesis using the runs test. Whereas 80% of stocks rejected the random walk hypothesis for Ghana, on the Stock Exchange of Mauritius, all the stocks in the sample rejected the random walk hypothesis at the 1% level of significance. For the other markets, more than half of the stocks for the BRVM (54%) and Egypt (54%) and exactly half the stocks for Botswana also rejected the random walk hypothesis using the runs test, whilst for Kenya, Zimbabwe, Tunisia and Morocco, less than half of the stocks in the respective samples rejected the hypothesis. For all the markets, except Kenya, the runs test indicates positive correlation tendencies for most stocks, when disregarding significance (see Table 6). The deviations from the random walk by the stocks on these markets suggest that the possibility of detecting patterns, which can be profitably traded upon, cannot be entirely dismissed. One clear exception is Namibia, where all the stocks in the sample, except one, exhibited random walk behaviour at the 5% level of significance. Kenya and Zimbabwe are also considered to be weak-form efficient since the majority of stocks conformed to the random walk hypothesis.

4.1 Higher order serial correlation[9]

Bekaert and Harvey (2002) indicated that emerging market stock returns exhibit higher order serial correlation. To investigate this assertion in the current research, a hypothesis that the correlation coefficients of trade-to-trade returns at all lags are zero is tested against the alternative that not all correlation coefficients are zero. This hypothesis is tested using the Box-Ljung Q-statistic, which is chi-square distributed with *k* degrees of freedom (χ_k^2). The null hypothesis that all the ten correlation coefficients are zero is rejected if the Q-statistic for the 10 lags is significant at the 5% level of significance.

The results, as summarised in Table 7, show that more than half of the stocks for each market, except Namibia and Zimbabwe, exhibit significant higher order serial correlation at the 5% level of significance.

[9]Results from the Box-Ljung, ACF and PACF are used here to show the prevalence of higher order serial correlation for African stock markets.

Table 6: Number and proportion of stocks with significant Z-values for the Runs test

Stock Exchange	Sample size	Largest Z-values (absolute)	Runs Test Z-values						Overall market
			All stocks		Significance at the 5% level			Correlation tendency	Proportions of rejections*
			positive	negative	positive	negative	total		
Botswana	12	3,92	-	12	-	6	6	Positive	50%
BRVM	24	6,04	1	23	-	13	13	Positive	54%
Egypt	54	5,70	11	43	1	28	29	Positive	54%
Ghana	20	9,55	1	19	-	16	16	Positive	80%
Kenya	40	5,18	24	16	11	1	12	Negative	30%
Mauritius	9	6,64	-	9	-	9	9	Positive	100%
Morocco	36	4,55	10	26	-	17	17	Positive	47%
Namibia	15	2,19	6	9	-	1	1	Not clear	7%
Tunisia	35	7,94	9	26	1	14	15	Positive	43%
Zimbabwe	39	6,20	10	29	-	14	14	Positive	36%

*This is equal to the number of stocks rejecting the random walk divided by the sample size (total number of stocks in the sample) as a percentage and is denoted p

Table 7: Number of significant higher order serial correlation coefficients and the proportions of significant Box-Ljung Q-statistics

Stock Exchange	ACF (for lags 2-10)									PACF (for lags 2-10)									Box-Ljung Q-stats
	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10	Proportions of rejections*
Botswana	5	4	1	2	0	3	0	0	1	6	2	1	3	1	2	1	0	1	66,7%
BRVM	12	6	3	6	3	3	3	1	3	10	6	1	4	3	3	3	0	3	66,7%
Egypt	27	6	11	3	6	6	7	3	7	24	3	8	1	4	4	6	2	3	77,8%
Ghana	14	12	8	5	5	2	2	3	4	11	6	4	1	4	1	2	1	2	85,0%
Kenya	9	5	5	7	2	0	2	0	4	7	5	5	5	4	0	2	0	5	52,5%
Mauritius	2	1	3	1	3	1	0	3	0	3	2	3	0	3	0	0	3	0	55,6%
Morocco	6	8	5	4	3	0	7	3	2	7	7	6	3	2	0	5	3	2	50,0%
Namibia	1	1	2	1	1	2	0	0	0	3	1	2	2	1	2	0	0	0	20,0%
Tunisia	10	4	4	5	7	6	4	0	2	6	4	2	4	5	6	3	0	1	60,0%
Zimbabwe	5	6	6	4	2	1	3	3	4	7	4	6	5	4	1	2	2	3	43,6%
Total	91	53	48	38	32	24	28	16	27	84	40	38	28	31	19	24	11	20	

* These are equal to the number of stocks with significant Box-Ljung Q-statistics divided by the sample size (total number of stocks in the sample) and are reported a percentages.

Table 7 also shows that the numbers of significant coefficients decrease with increasing lags for both the autocorrelation function (ACF) and the partial autocorrelation function (PACF), but only gradually. Therefore, while stock returns in the immediate past provide information that play a significant role in determining future returns, the information becomes less and less useful the further away in the past one looks. However, for the African stock markets in this study, the importance of historical price information only dissipates gradually and is therefore not totally irrelevant in forecasting future returns.

4.2 Discussion of results

The positive serial correlation observed on most of the markets is not surprising considering that daily data was used for an average period of 5 years. Positive serial correlation is usually considered to be a predictability phenomenon of the short-run, while negative serial correlation is mostly a long run predictability phenomenon. The positive serial correlation on African stock markets might also be a result of institutions imitating spreading their trades over several days to lessen the impact of trades in large volumes on the market (Asal, 2000). Most importantly, the prevalence of zero returns on these African stock markets as discussed in section 3 could have contributed to the nature of the results.[10]

The weak-form efficiency of the NSX can probably be explained by the market's positive correlation with the

[10] With this in mind, the results should be taken with a grain of salt as the serial correlation observed can be considered rather a reflection of the illiquidity of the markets.

JSE due to the significant number of stocks that are dual-listed on both markets. Tyandela and Biekpe (2001) found the correlation of the two markets to be 90% and the highest for all the market correlations that they studied. Considering some of the recent studies, the JSE was found to be efficient in Magnusson and Wydick (2002), Smith, Jefferis and Ryoo (2002) and Smith and Jefferis (2002). If the JSE is weak-form efficient, then one can argue that this efficiency filters through to the NSX since almost the same stocks are traded on both markets. About two-thirds of the stocks, which make up the sample for Namibia, are dual-listed on the JSE. The efficiency of the NSX can thus be said to be a spill-over from, or a reflection of, the weak-form efficiency of the JSE.

The efficiency of Kenya and Zimbabwe is also not surprising since the two markets are among the oldest in Africa. The two markets, probably, gained some sophistication over the years, enabling them to interpret and incorporate information into prices speedily. Fama (1965, p38) highlighted the importance of many sophisticated traders in a market, who can recognise situations where the price of a stock runs well above or below its intrinsic value, and who through their actions would cause such price bubbles to burst before they get underway.

The deviation from the random walk portrayed by the sampled stocks listed on the stock exchange of Mauritius cannot be readily explained. The rejection of the random walk hypothesis on this market might indicate the availability of exploitable profit opportunities, which may be due to investors not reacting quickly to new information and thus a slow adjustment of prices. Investors also, probably, adopt a passive investment strategy thereby failing to identify situations when prices deviate from their intrinsic values.

The rejection of the random walk by some Ghanaian stocks could be due to limited trading time on this market. The Ghana Stock Exchange was trading only three times a week, on Mondays, Wednesdays and Fridays for the period under study. This could have resulted in price adjustment delays and thus partly explain why stock prices on this market deviate from the random walk. If new information arrived on a Tuesday, which was a nontrading day on the Ghana Stock Exchange, investors would be in a position to reasonably predict the price movements for Wednesday when the stock market opens for trade.

The Z-values of the runs test are, however, small in magnitude for some stocks, but relatively large for others in comparison to those obtained in, for example, Fama (1965) and Dickinson and Muragu (1994). The largest Z-values, which are significant at the 1% level , exceed 5.0 for a number of stocks across markets, reaching to as high as 9,546 for Ghana. In Fama (1965), the largest standardised value for the runs test, also in absolute terms, was 4,23. Dickinson and Muragu (1994) also found very small values in their study of the Nairobi Stock Exchange, with the largest Z-values in absolute terms of 2,987. While Fama (1965) and Dickinson and Muragu (1994) hinted that the serial correlation they found may not be attractive to investors, the same cannot be readily said for the African stock markets studied. One major concern would be the illiquidity of these markets.

5. CONCLUSION

The paper investigated the weak-form efficiency of ten African stock markets using the runs test methodology for serial dependency. Returns were calculated on a trade-to-trade basis and weighted by the number of days between trades. Serious thin-trading was observed on all markets, and more so for Namibia and Botswana, the two markets with significant dual-listed stocks on the JSE. In all the markets studied (except Namibia), a significant number of stocks rejected the random walk. The weak-form efficiency of the NSX was attributed to its correlation with the JSE. Kenya and Zimbabwe were also concluded as generally weak form efficient, since a significant number of stocks conformed to the random walk.

All the stocks in the Mauritius sample rejected the random walk at the 1% level of significance using the runs test. This led to the conclusion that stock prices on the Mauritius market tend to deviate from the random walk hypothesis. The same conclusion was made for Ghana. On the BRVM, Egypt and Botswana stock exchanges, chances that one can detect patterns in the stock prices that can used to predict the next price also could not be ruled out.

Since rejection of the random walk does not necessary imply weak-form inefficiency, but the presence of serial correlation in stock returns, it is vital to investigate if such serial correlation can be exploited for abnormal returns, net of transaction costs. Therefore, there is need for further tests using technical trading methods that try to profitably exploit the serial correlation observed in this study, in order to reach definite conclusions on the efficiency or inefficiency of the African stock markets in this study.

The runs test used here only tests for the existence of a linear relationship, which makes it inadequate as a testing method on African stock markets where the return-generating processes are assumed to be nonlinear. This is because the assumptions on which the EMH is based are believed to be violated due to the heterogeneity of investors and the weak microstructures of the markets. The use of linear models would thus lead to wrong inferences being drawn. Therefore, further research is required to test the random walk hypothesis using nonlinear models and to investigate if the observed patterns can be profitably exploited.

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