Regional Integration of Equity Markets in Sub-Saharan Africa

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REGIONAL INTEGRATION OF EQUITY MARKETS IN SUB-SAHARAN AFRICA

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Abstract
Equity markets in developing and emerging economies have grown in number and importance as a result of financial market globalisation. However, their role in economic growth and development is enhanced if nascent markets are integrated with well-established ones. Market integration, measured by the transmission of returns volatility, is identified across a sample of SSA countries, using a unique dataset. Evidence for potential integration between financial markets in Sub-Saharan Africa (SSA) is found. Spillovers are found across markets, some uni-directional and others bi-directional. However, continued illiquidity and incomplete institutions indicate that an integrated financial community remains premature, and considerable regulatory reform and harmonisation will be necessary for this to succeed.
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1. INTRODUCTION

THERE IS AN INCREASING CONSENSUS that equity markets have a positive role in financial development and economic growth, although this remains controversial (see Singh, 1997). For example, Levine and Zervos (1996) consider that well-developed stock markets can provide a better impetus to growth than the banking system. Within this context, equity markets in developing and emerging economies have grown in number and importance over the past decade, largely as a result of the globalisation of financial markets. Standard measures of stock market performance include levels of liquidity and concentration, the presence or absence of excess volatility of market returns and asset pricing efficiency. High levels of efficiency indicate a low level of mis-pricing of risk between domestic and world capital market stocks, implying a degree of integration of national stock markets into world capital markets (Aristis and Demetriades, 1997). Thus, markets that are integrated are more likely to be successful than are those that remain segmented or isolated.

A great deal of attention has been given to market integration in the literature, although this has previously been confined to OECD countries or emerging markets in Latin America and Asia-Pacific. However, those in Sub-Saharan Africa have been largely ignored, perhaps not surprisingly, since in generally, these markets have been established only recently. In most cases, these markets are still very small and inactive and, consequently, may not be very effective. The exception to this is South Africa, which has a highly successful financial market and a stock exchange that is linked with world capital markets. Piesse and Hearn (2002) found evidence that the national stock exchanges of the countries within the Southern African Customs Union (SACU) are integrated by measuring the degree to which price volatility is transmitted across markets. The increased openness to efficient world markets, through the links they

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have with South Africa, has resulted in considerable benefits for neighbouring Namibia and Botswana. A system of regional groups that cluster around a more developed market may have widespread effects if these markets are found to be part of an effective network and hence integrated in a similar manner.

This paper examines volatility transmission across the returns structure of stock market indices from the ten national equity markets that collectively dominate the SSA region, using a new and comprehensive dataset. Where spillover effects are found, integration is likely to increase price efficiency as well as contributing to an understanding of developments taking place within and across these African markets. Clearly, well functioning financial markets will impact positively on the growth and development of these African countries. In many countries in Sub-Saharan Africa (SSA), the transition from a bank-based to a security market-based financial system has resulted in the establishment of many new equity markets over a very brief period of time. This transition results from a radical policy shift towards increased privatisation that has created a demand for greater access to capital. This in turn has required a move to liberalisation and deregulated markets in order that financial sector development and reform can facilitate economic growth. Therefore, it is no surprise that the rapid pace of development and change in these markets has generated considerable interest in understanding the mechanisms that transmit volatility between rival markets.

One factor contributing to the volatility in these new and rather vulnerable SSA markets is the significant amount of private capital investment that is attracted to emerging stock markets. Reform of regulation, particularly with respect to ownership and income repatriation, as well as the removal of capital controls, has increased the level of foreign portfolio involvement. This has been strengthened by the general improvement in financial reporting and the dissemination of stock price information on new growth areas for global investors. However, the dissemination of bad news is equally efficient, in some cases resulting in capital flight and increasing the volatility between markets still further (Kenny and Moss, 1998). This instability is particularly unfortunate as a major motivation for financial sector reforms is to increase savings and investment rates and attract foreign investment. At present, domestic participation in African financial markets is low and urgently needs to be reversed in order to assist economic growth, both by facilitating the privatisation programmes that are central to the policy of all governments in the region and to protect many small, open economies that remain seriously exposed to the whims of overseas investor sentiment. Crucially, hasty capital flight, combined with a persistent downturn in market sentiment internationally, can exacerbate a more general domestic financial collapse, which in turn may have a contagion effect as it spreads through the network of markets. The parallels between the 1997 Tequila crisis and the potential for such an effect in SSA are discussed in LSEcrefsa, 1997).

A major difficulty associated with establishing stock markets in developing and emerging countries is the perception that such markets are dominated by social, economic, and political uncertainties that ultimately have significant effects on market stability and the structure of returns. Historically, rates of return have been extremely high in many SSA markets, for example, in excess of 96 per cent in Botswana in 1997 in and 35 per cent in Zimbabwe in 1996 (The Namibian, 1998 and ING Barings Sub Saharan Markets Monitor, 1996). But equally, there have been extreme market downturns, such as the 46 per cent fall in the Ghana Stock exchange Index in 2000.

Political uncertainties, such as the continuing conflict in the Democratic Republic of Congo and Great Lakes region, also have adverse effects on investor confidence (Central Bank of Swaziland Annual Report, 1999-2000), as does the ongoing political unrest in Zimbabwe. Because of the inherent risks to entry of emerging economies to a growing and integrated marketplace, and the resulting transmission of volatility across national borders, there is an increasing level of research into the development of an appropriate regulatory design to minimise these undesirable effects. The current consensus is to upgrade and develop all the newly established financial markets within a proposed SSA area of regional integration to the level of the Johannesburg Stock Exchange.

Many of the countries in this sample share similar institutional characteristics, such as regulatory structure, commercial and legal systems, and their approach to economic development. Most of the countries in this study have long been influenced by English common law, with the principal exception being South Africa and Namibia, which follow the distinctive Roman-Dutch legal code. Not surprisingly, the inspiration sought by lawyers developing commercial codes for these countries following independence relied heavily on their colonial legacy. Much of the development history of Africa has emphasised the banking sector as the primary source of funds, in part due to the inherited system of commercial banks set up to support colonial trade. As a consequence of this, many countries have been reluctant to introduce securities markets at all, and in some cases, the banking system itself is still relatively underdeveloped and the provision of a stock market infrastructure very rudimentary indeed. Thus, a closer examination of these markets is timely, particularly the pivotal role these are required to play in economic growth and development.

The paper proceeds as follows. Section 2 provides a general profile of African financial markets, including data and descriptive statistics relating to the sample countries. Section 3 reviews the case for African capital market integration and the problems to be resolved prior to implementation. The next section briefly surveys previous work in this area and outlines the model and tests used in this study. Tests of volatility transmission and the direction of spillovers are in section 5. The final section concludes.

2. CHARACTERISTICS OF AFRICAN SECURITIES MARKETS

African securities markets have evolved rapidly during the last decade. The older and established markets have been restructured and expanded, such as those in South Africa, Nigeria and Kenya, and many new markets introduced, for example in Swaziland, Zambia, Tanzania and Mozambique. One of the more recent is the francophone Central African Community, established in December 2000 and now operating as a regional exchange, similar to that in Abidjan, with design, regulation and structural features based on the Mauritian Stock Exchange (World News, 2001). Markets in Tanzania and Uganda have increased equity listings and market capitalisation since their establishment in 1998 and 2000, respectively. Proposals for regional integration have progressed between Kenya, Tanzania and Uganda, with Kenya taking a leading position in the East African group (Uganda Securities Exchange website, 2001; Nairobi Stock Exchange website, 2001 Johannesburg Stock Exchange website, 2001).

With the notable exception of South Africa, SSA stock markets are small relative to

the overall size of the economy although there is considerable variability across the region. For example, between 1992 and 2000, the Botswana stock market doubled in size relative to the national economy, the markets in Zimbabwe, Kenya and Ghana increased over ten per cent, and Mauritius by over thirty per cent. In contrast, Swaziland remains small with the number of stocks listed, level of liquidity, and traded value consistently low and so far has failed to produce the rapid growth of the other regional markets. Table 1 provides background data on several countries, although not all exchanges in this study report these statistics.

Table 1. Sub Saharan African Markets - selected statistics (US$ millions), ranked by year established

	Year	GDP	Market capitalisation	Market cap / GDP (%)	Traded Value (pa)	Turnover ratio (%)	Number of stocks
South Africa	1992	130,533	103,537	79.32	7,767.00	7.50	683
(1887)	2000	133,461	170,252	127.57	58,347.00	34.27	668
Zimbabwe	1992	6,752	628	9.31	20.00	3.18	62
(1946)	2000	6,338	1,310	20.67	186.00	14.20	67
Kenya	1992	8,002	637	7.96	12.00	1.88	57
(1954)	2000	11,579	2,024	17.48	79.00	3.90	58
Nigeria	1992	32,710	1,221	3.73	4.00	1.15	153
(1961)	2000	41,353	2,887	6.98	160.00	5.54	186
Botswana	1992	4,147	295	7.11	15.00	5.08	11
(1989)	2000	4,876	724	14.80	70.00	9.67	14
Ghana	1992	6,413	84	1.31	0.40	0.48	5
(1989)	2000	7,501	1,384	18.45	59.50	4.30	21
Mauritius	1992	3,189	416	13.05	10.00	2.40	22
(1989)	2000	4,199	1,849	44.04	101.00	5.46	40
Swaziland	1992	967	111	11.47	0.36	0.33	3
(1990)	2000	1221	85	6.96	0.21	0.25	5
Namibia	1992	2,823	15,084		0.15	0.01	6
(1992)	2000	3,044	333,916		1,035.00	0.70	40

Turnover ratio represents the percentage ratio of Traded Value against Market Capitalisation. All figures are reported as end of period levels.
Namibian figures reported in local currency units (N$) and starting in 1993.
Sources: Emerging Stock Markets Factbook, 2000 and respective national stock exchanges.

Two major factors combine to make the introduction of successful security markets particularly difficult in many African countries: the ideological choice of socialist central planning, rather than a market based economy, that many countries followed after independence, and the lack of liquidity in the financial markets. Both are briefly discussed below.

(i) Transition to a market economy

Former socialist countries such as Ghana, Tanzania and Mozambique have made progress with introducing securities markets and each has successfully embarked on IMF sponsored programmes of financial sector reforms and development along market-orientated lines. All are committed to a domestic policy that has moved away from the post-independence model of development and growth through a centrally planned allocation and state provision of credit. Unfortunately, the slow response of some countries to implement reforms into systems of management and corporate culture has contributed to the small number of newly privatised enterprises that achieve compliance with listing and capitalisation requirements. For example, the fragile economy and weak domestic business sector in Mozambique has resulted in only a single company from the recent government privatisation initiative that met the

stringent requirements for listing. Thus, Mozambique is not in the sample. The experience in Ghana and Tanzania is very different. Fiscal adjustment programmes have been more successful and these markets have already developed to a more advanced stage.

But, despite these reforms, there is still considerable evidence of financial sector repression. Capital controls make foreign investment and repatriation of funds and profits difficult (see Jefferis, 1995). More importantly, there is inadequate regulatory structure and legal enforcement and until recently, the development and growth of countries dependent on banks as a source of finance have outperformed those based on stock markets across Africa.

(ii). Illiquidity and Thin Trading

Slow progress in market development and related infrastructure, and a shortage of investment options have exacerbated the general illiquidity of SSA markets. Historically, African markets have offered a limited, narrow range of products, with the principal role of the financial sector being to provide a source of domestic funding to offset the governments' budgetary deficits. Nigeria and Kenya are prime examples. This had the major disadvantage of crowding out trading activity by government, which left a very low level of new capital raised through private enterprise. Common factors still inhibiting market development are inadequate legal protection for investors and creditors, and poor supervision, monitoring and regulation. SSA equity markets continue to be characterised by low ratios of market capitalisation to GDP, as shown in the right-hand columns of Table 1.

Other constraints on liquidity are a function of trading practices. Most exchanges have limited trading hours and are closely time synchronous with other regional markets. There is generally little domestic stock market culture and awareness, and traditional domestic preferences for physically held commodities as a source of wealth, such as cattle, remain. Trading in the majority of markets is overwhelmingly dominated by a handful of stocks, even if more securities are actually listed, and bulk trading of a limited number of stocks in the smaller exchanges hinders activity on the domestic markets. Weakness in broker capitalisation also has adverse effects, reducing the ability to respond to arbitrage profits resulting from price differentials between rival stock markets in the case of dual listed securities – a common practice in developed markets. Institutional details, including market size, trading hours, and other trading arrangements for a sample of markets are reported in Table 2.

3. REGIONAL INTEGRATION IN SSA FINANCIAL MARKETS

Regional market integration within SSA is generally considered to be a viable approach to establishing functioning securities markets in the area, assuming that there are sufficiently close institutional links. The benefits of integration, including more globally competitive markets and increasing liquidity levels, have been recognised by the African Stock Exchange Association (ASEA) and four principal regional bourses in Johannesburg, for SADC members, Lagos, for West African exchanges, Nairobi, for the East African region, and Cairo for Northern Africa are preparing the infrastructure to ensure integration by 2006. Currently, reform of institutions including harmonisation of tax regimes and trading rules, settlement and legal systems with rigorous monitoring and enforcement of regulations are being established prior to formal integration.

Table 2. Summary of Institutional and Trading Arrangements on Sample Country Stock Markets

Market	Trading Hours	Trading Arrangement	Index	Details of Index Construction
Botswana	9-00am – 4-00pm: Mon to Thurs. 9-00am – 12-00noon: Fri.	Open Outcry	BSM Index (All Share)	Weighted All Share Index according to the volume of shares in issue and the current bid price.
Ghana	9-00am to 12-00noon. Mon, Wed and Fri.	Call Over. Continuous Auction Trading (CATS) system.	GSE All Share	Portfolio of all stocks listed in a capitalisation weighted format. Aggregate market capitalisation is expressed as relative to base market capitalisation.
Kenya	10-00 am – 12-00 noon	Open Outcry	NSE 20 Share Index	Geometric mean of top 20 companies.
Malawi	9-00 am – 12-00 noon	Call Over	MSE Index (All Share)	
Mauritius	9-00 am – 11-30 am	Open Outcry	SEMDEX (All Share)	The SEMDEX reflects capitalisation based on each listed stock that is weighted in accordance to its shares in the total market. In its computation, the current value of the SEMDEX is expressed in relation to a base period, which was chosen to be 5 July 1989, when Index was 100.
Namibia	9-00 am – 4-00 pm	Electronic (JET) trading link	NSX All Share	Capital weighted average with base period in 1992 at start of index – 100.
Nigeria	11-00am to 2-00pm	Call Over.	NSE All Share	All Share index is value relative and only considers common stocks (ordinary shares). Index computation takes place daily and index movement is expressed in relation to base level of 100 as of 3rd January 1984.
South Africa	8-25 am – 9-00 am: Pre-Opening. 9-00 am – 4-00 pm: Continuous Trading. 4-00 pm – 6-00 pm: Run-Off.	Electronic (JET) trading link	JSE/Actuaries Index	The price index is formed as the total market capitalisation divided by the market divisor. The market divisor is defined as the base value of capitalisation, and is attached to all corporate actions on market in an attempt to adjust these actions to keep overall index constant. Any capital structure changes need to be accommodated in the index divisor. Indices are under effectively constant review in terms of potential corporate actions.
Zambia	10-00 am – 12-00 noon	Call Over	LuSE Index	Basis: Market Capitalisation Weighted. This is a free float index–meaning the index includes only that portion of the shares in issue that is considered to be freely accessible to the public. This defined as all those shares in issue where the total quantity held by a single investor is 5 per cent or less. Start Date: 2nd January 1997. Base Value: 100
Zimbabwe	9-00–9-45am: 1st Session 11-45–12-30pm: 2nd Session	Call Over	Zimbabwe Industrial Index	Two market indices – Mining Index and Industrial Index. Both are calculated on capital weighted basis with base period being index at 100, or 1967.

All trading hours quoted are in local time. Nigeria and Ghana are –1 and –2 hours less than South Africa, Kenya and Mauritius are +1 and +2 hours ahead of South Africa. Source: Respective Stock Exchange websites.

In the East Africa region, interconnecting trading floors, shared computer networks and a central depository are expected as are listings requirements common to the countries within SADC. The establishment of a common central depository for South Africa and Namibia, SAFICAS, and a shared trading system, Johannesburg Electronic Trading (JET), has brought the settlement cycle to trade date plus five days (T + 5) and enabled a move towards a standard G30 settlement cycle of T + 3. This has increased liquidity between markets, although Namibia does have the highest number of cross-listed securities with South Africa, more than any SADC exchange.

Finally, a crucial factor to achieving market integration is the reconciliation of trading systems. South Africa adopted the JET system in 1996 although Namibia has had a computerised order matching system when the Stock Exchange was established and the two merged in 1998. Mauritius upgraded trading facilities to a computer based order-matching system in 2001, while Zambia co-ordinates trading through an order

matching, single price auction system, and developed the first SSA central depository that was fully automated and compliant with all G30 recommendations, apart from those relating to securities lending.

4. THE STRUCTURE OF BETWEEN-MARKET VOLATILITY TRANSMISSION

The literature on volatility transmission between national markets has developed from two distinct strands; that using econometric modelling techniques as in this study, and a more applied approach that analyses and develops a coherent framework of regulatory control in response to the perceived impact of imported volatility. Volatility clustering is a common phenomenon in financial time series. That is, a large shock, or residual, in one direction tends to be followed by another large shock in either the same or the other direction. Equally, small shocks tend to be followed by further small shocks. Thus, stock markets are characterised by periods of high volatility and more relaxed periods of low volatility. This is particularly true at high data frequencies, perhaps daily or weekly returns, but is less clear at lower frequencies.

The seminal paper by Engle (1982) suggested the concept of the autoregressive conditional heteroskedasticity (ARCH) model, allowing the variance of the residuals to be a function of their history. The popularity of this family of models, derived from autoregressive moving average (ARMA) methods are the centre of a large body of research, and ARCH methodology has led to valuable insights in many areas. One useful variant, proposed by Bollerslev (1986) is the generalised ARCH or GARCH model. Among the many features of time series returns structure that are successfully captured by ARCH and GARCH modelling are robustness to skewness and kurtosis, characteristics common to most African stock markets. However, an important restriction on the ARCH and GARCH specifications is their necessary symmetry. Only the absolute values of the innovations matter in determining the conditional time variance, not their sign. Thus, a negative shock has the same impact on future volatility as a positive one of the same magnitude, and forms the basis of much of the criticism of these models. For example, Black (1976) noted that stock returns are negatively correlated with changes in returns volatility, which means that volatility tends to rise in response to bad news, while falling in response to good news. This constrains the profile of volatility that GARCH models are able to emulate.

For countries such as the ones in this study, there is clearly the need for an asymmetric volatility model in which good news and bad news have different impacts on future volatility. This is captured in the exponential GARCH, or EGARCH, model that maintains the necessary feature of conditional volatility by making the volatility a linear combination (with positive weights) of positive random variables. EGARCH models are expressed in natural logarithms derived from a linear function of the explanatory parameters and their lagged counterparts. There is little integration reported amongst SSA markets, with the principal exception being between Namibia and South Africa, which do demonstrate a high degree of cointegration (see Piesse and Hearn, 2002). The lack of integration between these markets implies that volatility transmission effects are typically short term only and do not lead to any significant longer term change in the levels of stock indices. Thus, univariate EGARCH models are the appropriate method of analysis for this sample of African equity market since they can successfully model asymmetric impacts of good news (market advances) and bad news (market retreats) on volatility transmission with high levels of accuracy.

Finally, augmenting the EGARCH volatility model with another country's conditional volatility as an approach to mapping volatility spillovers is appropriate, considering the low degree of integration between these markets.

A number of empirical studies have concentrated on the analysis of volatility transmission mechanisms between national markets, using EGARCH methods. Bae and Karolyi (1994) investigated stock return volatility spillovers between the near perfect sequentially time non-synchronous markets of Tokyo and New York with a similar approach by Karolyi (1995) on the time synchronous markets of United States and Canada. Koutmos and Booth (1995) provided further insights by studying the Tokyo, New York and London stock markets and although New York and Tokyo are time non-synchronous, there is some overlap between the New York and London markets. More recent work by Booth *et al* (1997) outlines variations between different spillover environments that are dependent on time synchronicity of trading hours, and uses the EGARCH framework to investigate largely overlapping synchronous data from the four principal Scandinavian stock markets.

However, these studies are all directed towards developed OECD country markets and very little work has been done to analyse spillover effects in emerging and developing country markets. Appiah-Kusi and Pescetto (1998) go some way towards filling this gap, examining African stock markets using an EGARCH model, augmented by the other countries' conditional volatilities, to assess the degree of spillover or transmission between countries. The present study builds on their work, although it differs in two important respects. Firstly, this sample excludes extremely small and highly illiquid markets, such as Swaziland. This is because very small markets introduce markedly different influences from those that are much larger and more liquid (Bossone et al, 2001). Secondly, the scope of the analysis is extended by integrating the effects of inflation and the terms of trade into the indices. Adjusting the returns series by the US$ real exchange rate is entirely appropriate in a region where markets have historically been influenced by rapid changes in purchasing power parities. Thus, the results section draws on research undertaken at the UK Financial Services Authority, including the effects of inflation (Harley and Davies, 2001) and the cost benefit implications of establishing a regulatory structure (Alfon and Andrews, 1999).

5. EMPIRICAL ANALYSIS

(i) Data Issues and Preliminary Analysis

Several factors need to be considered prior to analysing high frequency financial data. These include the order of the time synchronicity of trade data and its frequency, the major structural features and simple diagnostic tests to assess whether ARCH and GARCH effects are present at all, and finally the significance of the autocorrelated lag patterns. In addition there are issues related to effects caused by macroeconomic influences that tend to be ignored in developed and OECD country analysis but that in emerging market regions can be considerable and may influence, and perhaps bias, the price indices.

In Booth *et al* (1997), different kinds of spillover environments were found ranging from markets where trading hours are near perfect time non-synchronous, to those where markets are perfectly time synchronous. The key differences between the two environments are the way in which they influence the necessary treatment of the returns data. The first only requires trading time returns to be taken into account

because the presence of perfectly non-synchronous trading can cause dependencies to exist that are not the result of information transmission. The second is characterised by simultaneous (synchronous) trading and therefore trading time or daily returns can be used. Bae and Karolyi (1994) and Koutmos and Booth (1995), amongst others, are examples of studies that solely consider the first type of non-synchronous trading time environment. Karolyi (1995) and Appiah-Kusi et al (1998) consider the second, including market close-to-close data in studies within time synchronous regions. In this study, the sample group of countries all fall within a region of +/- 2 hours from South Africa. Malawi, Zambia, Zimbabwe, Botswana and Namibia all are in same time zone as South Africa, while to the East, Kenya and Mauritius are one hour and two hours ahead, respectively, and to the West, Nigeria and Ghana are one and two hours behind, respectively.

Two other two major data issues can be considered simultaneously. Domestic macroeconomic influences commonly found within emerging market countries, such as extreme variations in exchange rates and high inflation, can have significant effects on stock price indices (Choudry, 2001). For example, Ghana and Kenya have recently experienced high inflationary pressures on domestic prices, and there is some evidence of inflationary pressure in Zimbabwe, although this is almost certainly underreported currently. To resolve this, and assess the true value of the underlying asset from a domestic investor perspective, nominal returns are generally discounted by the official inflation index. However, this is not possible in all cases because of missing or unreliable data, and so here the series were converted to US$, rather than retaining the nominal rates or deflating by a suspect local inflation rate. This gives a series that replicates the international investor perspective, assuming the purchasing power parity (PPP) hypothesis holds.[1]

The data consists of a comprehensive set of indices of closing stock market prices for all the major markets in SSA, obtained from the individual national stock exchanges. Much of the data is weekly and the few end of month series are adjusted to take account of trends throughout the month. All data are converted to natural logarithms. Ten SSA countries are included in this study, although the analysis is split into two samples, depending on the period of data available. Data for Botswana, Ghana, Kenya, Mauritius, Nigeria, South Africa and Zimbabwe are from January 1993 to January 2000. Then the analysis is repeated with a more inclusive sample, adding Malawi, Namibia and Zambia, for the period January 1997 to January 2000.[2]

A few comments on these data series are useful. The index for Botswana was fairly flat until the restructuring of the Botswana Stock Exchange in 1997, which led to the first listings of major foreign (mostly South African) corporations. This drastically increased market capitalisation to double the value of the previous year, a rise that was matched by the demand for domestic shares. The Nigerian stock index shows a smooth rise, with increased activity between the middle of 1996 and the end of 1997, which was probably due to political unrest and the resulting response by the international financial markets, followed by a steady decline. The Namibian index tracks that of South Africa very closely from 1997 when the trading was incorporated into JET. Mauritius has a

[1] This may not be the case as many countries in the sample have only recently relaxed extensive capital controls imposed following independence, and during that time had a system of fixed rate rates.

[2] Plots of these indices, using the longest data series available for each country, are available from the authors on request.

growing listing and is a more liquid market, although it is the only country in the sample that is dominated by domestic investment and where the market has been instrumental as a source of finance to the local economy. The recently introduced screen-based trading system would not have any effect on time series movements for returns, as it is recent and falls outside the sample time period. Finally, both Malawi and Ghana have very static series, for much of the period, essentially rising only with inflation, although in Ghana a series of privatisations, which were part of the governments structural reform programme to create an enabling business environment, did increase trading activity and domestic demand. Malawi had a very small domestic market during the sample period, characterised by periods of price rigidity, caused mainly by severe illiquidity.

Data from the countries in the longer sample coincide with the gradual removal of capital controls and increased regulatory reform. The shorter sample reflects the establishment of markets in Lusaka, Zambia and Malawi, and the first reports of their respective Stock Exchange indices. This is similar to Namibia, where data were not freely available in the past. The longer time series reflects the period of financial liberalisation and the lifting of capital controls between 1994 and 1995 in Nigeria and South Africa, so again is an interesting period for this study. Finally, and most importantly in the context of the regional integration of stock market activity in SSA as a whole, this period covers the years when South Africa's domestic markets were opened to international trading, following the end of apartheid. South Africa clearly plays a central role in the success of the regional market in SSA (see Hearn and Piesse (2001) for further evidence of this).

Tables 3 and 4 show summary statistics for both sample groups. Test statistics for both skewness and excess kurtosis indicate that all returns series demonstrate significant deviations from normality, a feature that can be modelled using ARCH techniques. The Ljung-Box test statistics demonstrate significant statistical dependence on lags extending for six and twelve periods in most of sample countries, again validating the choice of ARMA models to capture features within returns series.

Table 3. Index Returns Series - Sample Statistics (January 1993 – January 2000)

	Botswana	**Ghana**	**Kenya**	**Mauritius**	**Nigeria**	**South Africa**	**Zimbabwe**
Mean	0.00273	0.00199	0.9078 x 10-5	0.00120	-0.00018	0.000381	0.002557
Variance	0.01830	0.02767	0.034737	0.02142	0.06320	0.02730	0.038495
Skewness	0.09444	1.4270	2.9412	2.9412	-2.2272	-0.95766	-0.6320
Excess Kurtosis	7.9486	6.9815	19.5229	5.4271	16.7245	7.4712	2.7107
1st order autocorrelation coefficients	0.39423	0.57562	0.53872	0.15238	-0.04815	0.20851	0.49412
Ljung-Box (6) test	153.5990	279.1867	159.8056	21.2266	15.8446	26.1790	183.6103
Crit val: 12.592	[.000]	[0.00]	[.000]	[.002]	[.015]	[.000]	[.000]
Ljung-Box (12) test	164.9672	285.6515	160.4714	22.5115	21.2506	41.5703	201.7337
Crit val: 21.026	[.000]	[.000]	[.000]	[.032]	[.047]	[.000]	[.000]
ARCH(12) LM test	27.49**	45.72**	28.49**	60.42**	97.42**	71.68**	42.41**
	Correlation coefficients						
Botswana	1	0.043735	-0.0321	-0.0271	-0.0144	-0.1455	0.0266
Ghana		1	-0.10942	0.07723	0.03306	0.1113	-0.08005
Kenya			1	0.0786	-0.0853	0.0060	0.1490
Mauritius				1	-0.0567	0.0025	-0.0352
Nigeria					1	-0.0381	0.0699
South Africa						1	0.2254
Zimbabwe							1

Source: Respective countries stock exchanges. ** Significant at 95 per cent level

The Ljung-Box test statistics demonstrate significant statistical dependence on lags extending for six and twelve periods in most of sample countries, again validating the choice of ARMA models to capture features within returns series. Each series was tested for the presence of ARCH effects, using the Lagrange multiplier test (Engle, 1982), preliminary to the EGARCH analysis. Ljung-Box test statistics demonstrate that in almost all cases there is a strong dependence on past values.

(ii) The model

As discussed above, one of the most appropriate methods of examining volatility transmission between these African stock market indices is the EGARCH model suggested by Nelson (1991), because it allows a more flexible dynamic lag structure and does not require symmetry. The first stage is the simple ARCH(1) form that can be stated

$$\sigma^2{}_t \equiv E\{\varepsilon^2{}_t \mid \Omega_{t-1}\} = \varpi + \alpha\varepsilon^2{}_{t-1}, \varpi, \alpha \geq 0 \quad (1)$$

where Ω_{t-1} is the information set, typically including ε_{t-1} and its history. This can be extended to an ARCH(p) process by varying the lag length

$$\sigma^2{}_t = \varpi + \alpha_1\varepsilon^2{}_{t-1} + \alpha_2\varepsilon^2{}_{t-2} \ldots \alpha_p\varepsilon^2{}_{t-p,}\varpi, \alpha_i, \geq 0 \quad (2)$$

Table 4. Index Returns Series - Sample Statistics (January 1997 – January 2000)

	Botswana	**Ghana**	**Kenya**	**Malawi**	**Mauritius**	**Namibia**	**Nigeria**	**South Africa**	**Zambia**	**Zimbabwe**
Mean	0.00827	0.001584	-0.00411	-0.000963	-0.00073	-0.001422	-0.00521	-0.00121	0.00035	-0.00702
Variance	0.02466	0.031178	0.02158	0.042367	0.1832	0.046397	0.07833	0.03562	0.04640	0.04774
Skewness	-0.9911	1.1293	1.1766	0.62452	0.23555	0.03374	-0.48228	-0.9911	0.03374	-0.4921
Excess Kurtosis	5.3116	7.0224	5.3155	13.8704	4.1210	3.0312	5.4934	5.4934	3.0312	1.1386
1st autocorrelation coefficients	0.4744	0.5495	0.2809	-0.19430	0.06440	0.12766	-0.43169	0.25565	-0.22818	0.48714
Ljung-Box (6) test	84.1426	107.84	21.4832	20.6116	7.7781	8.8906	38.6825	21.0304	19.9615	82.9645
Crit val: 12.592	[.000]	[.000]	[.002]	[.002]	[.255]	[.180]	[.000]	[.002]	[.003]	[.000]
Ljung-Box (12) test	91.8915	111.4219	27.5518	22.4956	19.7504	11.2787	43.6893	34.3511	27.4518	85.7866
Crit val: 21.026	[.000]	[.000]	[.006]	[.032]	[.072]	[.505]	[.000]	[.001]	[.007]	[.000]
ARCH (12) LM test	6.71	21.10*	4.37	21.13*	40.93**	28.45**	32.13**	26.86**	26.43**	25.17**
	Correlation coefficients									
Botswana	1	0.06975	-0.1259	-0.0103	-0.1500	0.1734	0.0158	0.2151	0.0849	0.1181
Ghana		1	-0.1092	0.0419	0.2097	0.1412	0.0154	0.1341	-0.0116	-0.1501
Kenya			1	0.1144	0.0578	-0.0022	0.0456	0.0560	0.0046	0.0028
Malawi				1	-0.1023	0.0217	0.0651	0.0865	-0.1330	-0.0164
Mauritius					1	-0.0817	0.0617	-0.1500	0.0556	-0.1619
Namibia						1	0.0592	0.3476	0.0286	0.2537
Nigeria							1	-0.0876	0.0592	-0.0117
South Africa								1	0.1041	0.2644
Zambia									1	0.1381
Zimbabwe										1

Source: Respective countries stock exchanges.

** Significant at 95 per cent level; *Significant at 90 per cent level

The GARCH(1,1) process includes the lagged conditional variance, as follows

$$\sigma^2{}_t = \varpi + \alpha\varepsilon^2{}_{t-1} + \beta\sigma^2{}_{t-1}, \alpha, \beta \geq 0 \quad (3)$$

an expression with three parameters to estimate. Finally, to include asymmetry, the log form of the EGARCH model is given by

$$\ln \sigma^2_t = \varpi + \beta \ln \sigma^2_{t-1} + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \alpha \frac{|\varepsilon_{t-1}|}{\sigma_{t-1}}, \gamma \neq 0 \quad (4)$$

where ϖ, α, β and γ are the parameters to estimate. Because the level $\varepsilon_{t-1}/\sigma_{t-1}$ is included, the EGARCH model is asymmetric while $\gamma \neq 0$. When $\gamma < 0$, positive shocks (good news) generate less volatility than negative shocks (bad news). The EGARCH model can be extended by adding further lags. Equation (4) can be rewritten

$$\begin{aligned} \ln \sigma^2_t &= \varpi + \beta \ln \sigma^2_{t-1} + (\gamma + \alpha) \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad if\ \varepsilon_{t-1} > 0 \\ &= \varpi + \beta \ln \sigma^2_{t-1} + (\gamma - \alpha) \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad if\ \varepsilon_{t-1} < 0 \end{aligned} \quad (4a)$$

Typically, it is expected that $\gamma + \alpha > 0$ while $\gamma < 0$.

Since volatility spillovers are the particular focus of this paper, the EGARCH models are estimated pairwise univariate, that is, all the single-country EGARCH processes are augmented by the conditional volatility of all the other countries, individually. The final model is specified as

$$\ln \sigma^2_{i,t} = \varpi + \beta \ln \sigma^2_{i,t-1} + \gamma \frac{\varepsilon_{i,t-1}}{\sigma_{i,t-1}} + \alpha_i \frac{|\varepsilon_{i,t-1}|}{\sigma_{i,t-1}} + \theta \sigma^2_{j,t-1}, \gamma \neq 0 \quad (5)$$

where *i* is the primary country and *j* the secondary country. The estimated parameter, θ, measures the extent of volatility spillovers between the markets.

(iii) Intra-Market volatility

Plots of the EGARCH volatility profiles for each country show that, in general, the markets exhibit changes in conditional volatility over time, with some flat periods and others with localised, more extreme volatility. Mauritius and Nigeria are clear examples of this. In Kenya, the localised increase in volatility coincides with the abolition of exchange controls in 1994 and the flotation of the Kenyan shilling on international markets. There is a second, similarly sized peak at the start of 1995, which is probably due to the relaxation of restrictions barring foreign portfolio investment in the domestic market. A sharp increase of volatility that occurred in early 1997 corresponds to foreign investor activity and heavily oversubscribed privatisation of parastatals, although following this period of localised activity the market returns to its previously low levels due to illiquidity.

Returns in Zambia are volatile throughout the period, although decreasing steadily over this shorter sample. The effects of the fully automated central depository and a well-organised marketplace, are efficient mechanisms to retain liquidity and hence volatility, even though Zambia does remain a small market. Positive effects such as market liquidity and openness to foreign investment, and negative effects such as an excessive regulatory burden, are important determinants in market volatility. It is clear in several of these sample countries, when news is available to market participants, illiquidity severely hinders the ability to initiate exit strategies.[3]

[3] Some caution is required in interpreting the data for Zambia. Multiple structural breaks can be identified and thus the parameter coefficients could exhibit instability, for which there is no documented remedy.

For Nigeria, the volatility profile is fairly flat. The large peak in 1995 can be directly attributed to the January flotation of the Nigerian naira, and the subsequent devaluation and decline in the terms of trade with respect to the US$. Initial regulatory liberalisation, such as opening the domestic market to foreign involvement, and good local corporate performance, increased domestic demand in a largely illiquid market (Appiah-Kusi, 1998). Later, volatility increases in 1997 are likely to be a combination of the political situation affecting stock returns, plus a fall in demand for Nigeria's exports from South-East Asia. Similar patterns in South Africa, Namibia and Botswana are also attributed to the international transmission of the Asian currency crisis, again worse in those countries with significant exports earnings to that region. However, the increase in volatility in the latter two markets can better be explained by internal market structure linkages, such as the shared JET system. In Botswana, financial sector reform and deregulation led to an increase in foreign listings that provided an incentive for domestic demand. Botswana has experienced a much greater level of sustained market volatility since early 1997, largely due to the higher levels of liquidity than in other markets. This is a direct consequence of a more mature institutional structure, and Botswana's proximity to South Africa, plus the advanced degree of harmonisation and integration of SADC member exchanges.

The profile of Mauritius is largely dominated by a period of volatility during 1994 and early 1995, following the abolition of exchange controls in 1994, and the opening of the domestic market to foreign involvement for the first time. However, this period of volatility is short lived, with the market largely being quite flat, apart from a few peaks, for the remainder of the period. Although there were increases in market capitalisation, a greater number of listed stocks, and a higher turnover ratio, the market remains illiquid.

Table 5. Univariate EGARCH regression parameters (January 1993 – January 2000)

Market	Model	ϖ	β	γ	α
Botswana	EGARCH(1,1)	-0.77091	0.90820	0.17903	0.34877
		(0.4360)	(0.0516)	(0.0632)	(0.1373)
Ghana	EGARCH(1,1)	-0.95877	0.87499	0.06855	0.66996
		(0.37707)	(0.0496)	(0.0864)	(0.21624)
Kenya	EGARCH(1,1)	-0.52275	0.93028	0.064457	0.26839
		(0.3890)	(0.0526)	(0.0491)	(0.1291)
Mauritius	EGARCH(2,1)	-6.3869	0.17727	-0.006706	0.70861
		(1.7955)	(0.2278)	(0.1118)	(0.1663)
Nigeria	EGARCH (9,1)	-4.1532	0.26823	0.19469	0.61821
		(0.5667)	(0.0947)	(0.0771)	(0.0792)
South Africa	EGARCH(1,1)	-.27589	0.96333	-0.06153	0.28710
		(0.1650)	(0.0225)	(0.0486)	(0.0881)
Zimbabwe	EGARCH(2,1)	-3.3892	0.49936	0.012889	0.65806
		(0.7159)	(0.1020)	(0.0943)	(0.1604)

Values in parentheses are asymptotic standard errors

Tables 5 and 6 report the results for the tests of the asymmetric relationships derived from the EGARCH models. The coefficients are obtained by maximum likelihood estimation, assuming the conditional distribution of the errors is normal. The asymmetric relationship between returns and volatility, represented by γ in equation (3) suggests that in Botswana and Nigeria volatility tends to rise when return surprises are

This subject is an area of current research, and although progress has been made in cointegration models, little has been reported in the area of flexible GARCH modelling techniques that incorporate structural breaks without losing explanatory power and parameter stability.

positive (γ is positive and significant) but for South Africa, volatility tends to rise when return surprises are negative (γ is negative and significant). Thus, in all three, volatility is asymmetric. For the other countries in the sample there is no evidence of asymmetry as γ is not significantly different from zero.

Table 6. Univariate EGARCH regression parameters (January 1997 – January 2000)

Market	Model	ϖ	β	γ	α
Ghana	EGARCH(1,1)	-0.38120 (0.16068)	0.95047 (0.02076)	0.15763 (0.04146)	0.20007 (0.05608)
Malawi	EGARCH(9,1)	-10.9809 (0.8217)	-0.59651 (0.1075)	-0.57463 (0.0959)	0.43771 (0.1134)
Mauritius	EGARCH(1,1)	-4.7351 (1.8810)	0.41971 (0.2286)	0.10313 (0.1502)	0.76946 (0.2384)
Namibia	EGARCH(1,1)	-0.13601 (0.0944)	0.95850 (0.0200)	-0.53015 (0.3469)	0.51252 (0.6955)
Nigeria	EGARCH(1,1)	-0.05507 (0.1036)	0.98435 (0.0163)	-0.025701 (0.0842)	0.71242 (0.1226)
South Africa	EGARCH(1,1)	-0.20890 (0.1128)	0.96920 (0.0173)	-0.25055 (0.0702)	0.15582 0(.0970)
Zambia	EGARCH(2,1)	-11.3461 (0.2783)	-0.97044 (0.0313)	0.099527 (0.0514)	0.12411 0(.0586)
Zimbabwe	EGARCH(1,1)	-0.94397 (0.4207)	0.85822 (0.0630)	-0.10624 (0.1101)	0.46644 (0.1648)

Values in parentheses are asymptotic standard errors

Volatility Asymmetry Relationships

The other coefficient of interest is β, indicating the degree of the persistence of volatility. As the EGARCH plots show, most of the countries have increased returns volatility later in the period. For the first group (1993 to 2000), Mauritius and Nigeria have only localised volatility, Zimbabwe at the beginning and end of the period and Botswana, Kenya and South Africa have persistent volatility throughout. The large value of β for this last group supports the visual evidence. In the 1997-2000 group, all countries exhibit persistent volatility, with the exception of the largely domestic Mauritian market, due to international effects and extensive deregulation across Africa. There is considerable variation in the number of lags required to capture the persistence of volatility across the sample.

(iv) Inter-Market volatility transmission

Finally, Tables 7 and 8 report the results of the EGARCH models that incorporate the volatility measures from each of the sample countries. This searches for evidence of volatility transmission, or spillovers, between countries. Spillover effects are more likely where there are close links between countries, whether this is a trading relationship, membership of a common currency area or linked stock market trading mechanisms. Thus, where θ is significantly different from zero, the hypothesis that volatility is transmitted from country *j* to country *i* is accepted. Many of these results are intuitively predictable. For example, in Table 7, it is shown that volatility in Botswana and Zimbabwe affects that in South Africa because of macroeconomic and trade linkages, including their mutual concentration on exports to the European Union, but also as a result of the integration already within SADC. South Africa is sufficiently dominant to be robust to volatility in the smaller markets, although it retains bi-directional volatility links with Botswana and Zimbabwe, probably through strong localised trading interdependencies. Regional patterns in volatility can also be seen with respect to Nigeria and Ghana, in western Africa, being affected both by Kenya in the east and the SADC countries in the south. On the other hand, although the results for Mauritius

indicate a bi-directional volatility relationship with Zimbabwe, it uni-directionally affects both the markets of East Africa and Southern Africa, although not the more internationally accessible market in Johannesburg.

Table 7. Volatility Transmission between Markets, θ estimates Direction of Volatility from Country j to Country I (January 1993 – January 2000)

Country j → Country i ↓	Botswana	Ghana	Kenya	Mauritius	Nigeria	South Africa	Zimbabwe
Botswana	-	na	0.42157 (1.3783) Reject	-4.4433 (2.0066) Accept	-1.7385 (1.5663) Reject	21.2924 (9.1865) Accept	2.7316 (1.9024) Reject
Ghana	na	-	18.5723 (6.0465) Accept	-13.9262 (1.9134) Accept	0.7546 (0.9990) Reject	5.9900 (2.4871) Accept	16.8524 (5.1643) Accept
Kenya	-20.9745 (9.1325) Accept	12.6505 (5.5863) Accept	-	-15.9945 (3.3522) Accept	4.6460 (1.7697) Accept	9.1585 (10.6640) Reject	-18.0063 (3.8442) Accept
Mauritius	-17.7988 (10.8936) Reject	-15.1489 (4.4724) Accept	-13.2279 (9.2103) Reject	-	-1.6401 (2.7001) Reject	-7.5455 (9.5605) Reject	-21.0796 (6.0776) Accept
Nigeria	33.1020 (8.9247) Accept	-36.8485 (2.2133) Accept	26.4521 (4.7425) Accept	na	-	-105.5263 (8.5194) Accept	na
South Africa	4.5703 (2.1175) Accept	10.8171 (2.7241) Accept	.68735 (1.4893) Reject	-2.3931 (2.3216) Reject	0.96278 (1.0838) Reject	-	10.2955 (2.1963) Accept
Zimbabwe	0.12066 (4.2155) Reject	16.2621 (4.9749) Accept	-0.26100 (2.7623) Reject	-5.0994 (2.7808) Accept	1.9432 (1.7413) Reject	8.2356 (4.0710) Accept	-

Conditional parameters for spillover variables reported with asymptotic standard errors in parentheses

In Table 8, it can be seen that the shared JET system results in high levels of volatility spillovers in each direction, with a large value of θ (51 and 6, respectively) between South Africa and Namibia.

Table 8. Volatility Transmission between Markets, θ estimates Direction of Volatility from Country j to Country i (January 1997 – January 2000)

Country j → Country i ↓	Ghana	Malawi	Mauritius	Namibia	Nigeria	South Africa	Zambia	Zimbabwe
Ghana	-	-3.1615 (4.8961) Reject	na	na	na	0.54550 (1.2672) Reject	18.0457 (15.8029) Reject	1.5987 (2.5047) Reject
Malawi	na	-	62.7186 (23.4046) Accept	-13.2807 (2.8317) Accept	-2.1154 (1.0249) Accept	-33.1745 (7.3474) Accept	na	-16.3120 (3.8246) Accept
Mauritius	na	-14.3039 (9.2377) Reject	-	7.0472 (5.2095) Reject	-2.1112 (2.6466) Reject	13.9400 (12.0388) Reject	11.7651 (12.2395) Reject	-23.9616 (58.2418) Reject
Namibia	13.6695 (4.0792) Accept	Na	84.8512 (22.7264) Accept	-	-.98576 (.76677) Reject	67.4852 (14.5417) Accept	na	na
Nigeria	-36.0722 (3.5499) Accept	8.5597 (4.6564) Reject	na	-31.2518 (3.5047) Accept	-	-30.7938 (4.0685) Accept	-6.0836 (8.9322) Reject	-39.0155 (4.1750) Accept
South Africa	11.3117 (3.1665) Accept	-9.5775 (8.3371) Reject	-12.7267 (10.1462) Reject	51.0808 (9.6512) Accept	-8.6071 (3.3036) Accept	-	-5.7382 (16.1095) Reject	10.3388 (2.7218) Accept
Zambia	na	3.6784 (10.089) Reject	-9.8769 (20.7510) Reject	na	2.6138 (1.2769) Accept	na	-	na
Zimbabwe	na		-17.9746 (10.4451) Reject	-1.2165 (2.2769) Reject	.055017 (.75080) Reject	-.13941 (3.1142) Reject	14.6755 (15.1780) Reject	-

Conditional parameters for spillover variables reported with asymptotic standard errors in parentheses.

There is a mutual effect, too, between South Africa and Nigeria, the largest markets in their respective regions in terms of GDP and stocks listed.

Recently, both countries have made progress towards harmonisation of listing requirements and dual listing, notably the listing of a South African company on the Nigerian Exchange in 2000. Differences in volatility spillovers can be seen within the west African region, with Ghana exporting unidirectional volatility to Nigeria, which is to be expected, as Ghana has significantly more liquidity. Major differences between these two samples show the lessening of the role of Mauritius, as purely domestic trading lessens the importance of markets, while Nigeria has grown in terms of influence, more lately having some impact on the volatility profile of South Africa. Over the shorter period, the strong bi-directional spillover between Mauritius and South Africa with Zimbabwe has faded, being replaced by unidirectional spillover in volatility from Zimbabwe to other Southern African neighbours.

Malawi appears to be quite different from the other countries in the shorter sample. Whereas most of the small, but rapidly developing markets are more likely to import volatility inter and intra regionally, the size and significance of θ in the Malawi equation indicates that imported volatility effects are strongest intra regionally, from South Africa and Zimbabwe. This is probably due to dual listing of a number of South African securities. Conversely, there is a much weaker inter regional effect from the west, especially Nigeria.

In summary, there is evidence of spillovers, some of which can be explained by the pure mechanics of trading, such as shared systems and the importance of trading in goods and services, both between countries and with the European Union. Indeed, it would be interesting to extend the study to examine the influences of other exogenous trading areas. But while these spillover effects are encouraging in terms of future integration and progress in the development of a capital market-based approach to development and economic growth in Africa, there is also the negative outcome that poor market performance could spread due to contagion. It would be unfortunate if the benefits of the proposed financial market integration in Africa were to be overshadowed by a possible repetition of the spread of the 1998 financial crisis in South East Asia.

6. CONCLUSIONS

In a number of African countries, the emphasis on growth and development has shifted from a bank-based system to one that is dependent on capital markets as a source of finance for the business sector. This has resulted in the establishment of a number of new stock exchanges and the restructuring and reform of many of the existing ones. Although still highly illiquid, and with only a limited culture of participation by the business and investment community, many of these appear to be making progress. But most importantly, the markets that are integrated with world capital markets, through their link with a highly developed market that acts as a regional hub, do better than those that are segmented. A major factor in the success of national stock markets is the provision of the necessary institutions to provide investor confidence. Markets that are G30 compliant have a clear advantage and countries that have achieved this are potential members of an integrated system for electronic trading and settlement. Harmonised tax regimes, accounting systems and the commitment to enforce regulation are also essential, which are additional hurdles for many countries in the

region that are already overburdened with privatisation programmes and the establishment of a competitive business environment.

This paper analyses volatility within and between the securities markets of Sub-Saharan Africa using a dataset that scans the entire region. An EGARCH model is used to estimate asymmetries in volatility and finds that these SSA stock markets exhibit volatility in their price indices that is transmitted differently through the markets. Firstly, the fairly liquid markets exhibit active trading for much of the time. The others are still highly illiquid and are characterised by low levels of inactivity, but with localised extreme volatility. The effects of other country stock markets are also incorporated to test for volatility transmission, or spillover effects, between markets. The results show that the dominant markets of South Africa and Nigeria transmit their volatility to other local markets. This effect is particularly significant where there are strong trade links or a shared mechanism for stock market trading and settlement. The results of the EGARCH methods used here are interpreted in the light of regulatory and policy design structures (see Roll, 1989), where explicit consideration is made of the framework of reform and increased inter-market linkages.

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